The Glass Industry
REG. U. S. PAT. OFF.

Vol. 8 NOVEMBER, 1927 No. 11

The Flow of Glass in Tanks

By D. J. McSwiney[1]

PART II

The viscosity of the glass in a tank is never the same throughout, but, instead, it may vary greatly; the rate of flow of the glass in different portions of the tank will then show corresponding variations. There is normally no abrupt variations in viscosity or rate of flow in any portion of the tank, but, on the contrary, the viscosity, and consequently the rate of movement, changes gradually from one section to another.

Although there is no sharply defined channel of flow in the tank, distinction should be made between that flow which accounts for the passage of most of the glass through the tank and the slower movement which contributes but little to this volume of glass. The first more rapid movement through the main channel of flow determines to a large extent the effective capacity of the tank and the rate at which batch or color changes will move through the tank; the second slower movement is of importance in its relation to streaking or sloughing of old glass, scum, etc., into the main glass stream.

The lines of flow will not only vary with the construction of the tank—whether the tank is equipped with throat or floaters, the number of throats, their depth below the metal line, etc.—but, as stated above, the flow of glass in any particular tank will vary greatly, depending on the rate of viscosity change through the tank. In the melting chamber of any tank, there is usually some movement over the entire surface, even in the corners, provided no surface scum is present. As is the case with any liquid, the most rapid flow tends to be down the center line of the tank, but this tendency is usually offset to some extent by the filling operation or by non-uniform heat distribution in the tank. The drop in rate of flow towards the sides of the container tends to be greater in the case of glass than with other less viscous liquids. As mentioned above, the amount of movement in the rear corners of the tank depends largely on the action of the filling operation; the movement in the front corners of the tank is usually less than that in the rear corners, unless the tank is very narrow, the amount of movement at this point depending largely on the type of outlet from the melter to the refiner and being very much greater in tanks equipped with floaters or with more than one throat than in those tanks equipped with a single throat in the center of the bottom; the movement here is also greater in the case of those glasses in which surface flow predominates than with the usual flint glass throat-equipped tank operation. The effect of increased surface flow on the movement of glass in the front corners can be seen in a tank in which there is a scum accumulation at these points; when the throat is new and unworn, but little of this scum will usually be drawn into the glass stream, but when the throat becomes worn too near the metal line, scum from the corners is easily drawn into the refiner.

Color changes are not common in tanks equipped with floaters, but from observation of variations in tint it would appear that the main channel of flow in such tanks is not deeper than eight inches along the sides and twenty-four inches along the center line. In a throat-equipped tank of normal width, when the throat is worn nearly to the metal line, the main line of flow under an average pull appears to be about eighteen inches deep down the center and may be only three or four inches along the sides of the tank.

The volume of the main channel of flow increases with the depth of the throat below the metal line, so that with the same glass under the same furnace conditions the volume of glass moving through the melter is greater with a sump throat than with one on or above the floor level.

Under definite furnace conditions, the greatest differences in viscosity obtaining in a tank are those which result from differences in color; this is owing to the influence exerted by color on the radiant heat transmitting power of, and, consequently, the temperature drop through, the glass. The drop in temperature through a dark colored glass is very much more rapid than that through a flint or light green glass; the temperature of a flint glass within a few inches of the bottom of an average tank may be as high as that of a

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For Part I see July, 1927, issue, page 155.

very dark glass within a few inches of the metal line, under the same furnace conditions. For example, a tank of flint glass showed with an optical pyrometer an average surface temperature of 2,540 deg. F. and an average temperature, with a couple eight inches above the bottom (thirty-six inches below the metal line) of 2,325 deg. F.; the same tank filled with a dark (chrome) green glass, showing a surface temperature of 2,560 deg. F., gave a temperature of only 2,080 deg. F. fifteen inches below the surface along the walls. The temperature of the glass is not uniform throughout any horizontal level, but, instead, the glass is usually hotter in front of the throat and doghouse, especially in the darker colored glasses; this condition is the result, and not the cause, of increased flow at these points.

As a result of the difference in rate of temperature drop downward through the glass, the channel of flow in a flint or light green glass may be nearly the full depth of the tank in the center, decreasing in depth towards the sides, especially towards the corners, while the flow in a dark colored glass is much more shallow and may be confined to within a few inches of the surface, the depth varying with the ability of the glass at high temperatures to transmit radiant heat. Observation indicates that, in proportion to the depth of color of the cold glass, the dark green glasses transmit radiant heat less at melting temperatures than do the amber, red or blue glasses. The flow of the glass being more shallow or surface flow in the case of the dark than of the light colored glasses, the rate of flow through the tank is greater with the dark glasses than in the case of flint or light green.

The effect of color and of outlet from the melter can be seen in the length of time required for a batch or color change to show at the working points, the changes always showing more quickly under the same conditions the darker the glass and the more shallow the throat. For example, in a tank melting dark green glass and using a sump throat, a batch change would show at the machines in about sixty

Photo by Toledo Scales

BATCH-FEEDING EQUIPMENT IN THE LIBBEY-OWENS SHEET GLASS COMPANY'S PLANT AT CHARLESTOWN, WEST VIRGINIA

The raw materials of the glass batch after being mixed by automatic machinery are dumped from overhead bins into the scale hopper which is located inside the levers. A record of each batch is made and the material then discharged through the chute into the furnace.

hours after it was filled in, while, under the same pull in the same tank with a throat only twenty inches below the glass line, a similar change would show in about twenty-four hours; with amber glass and a floor level throat in about sixty hours, and with flint glass in a sump throat in about ninety-six hours, these changes being made without fluctuation in glass level. The variations in heat transmission and, consequently, in the depth of the channel of flow are much greater among different dark colored glasses than among light colored glasses.

For the purpose of observing the lines of flow through a tank and the rate of interchange of glass of one color by that of another, F. C. Flint, of the Hazel-Atlas Glass Co., has constructed a small experimental tank modeled after a bottle tank, and equipped with plate glass sides and throat. The tank was filled through the doghouse with a light colored viscous glucose solution and the liquid was heated by means of resistors placed under the crown. Dark colored glucose of the same viscosity was then fed in at the doghouse at a rate proportionate to that at which a glass tank is fed with batch and the progress of the dark colored liquid through the tank was observed through the walls and throat.

As the surface flow of a dark colored glass through a tank is more rapid than that of a flint glass, it would appear that the allowable pull on a tank with dark colored glass would be lower than that of the same tank with flint glass. However, experience would indicate that there is not any great difference between the maximum allowable pull on two glasses of different color in the same tank. The factor which determines the maximum allowable pull on a flint tank is the rate of refining; the first indication that the tank is overpulled, being usually the presence of seedy glass in the refiner; on the other hand, the first indication of an overpull on a dark colored tank is often the presence of unmelted batch material in the glass in the refiner. Such material seldom shows in a flint glass refiner under normal batch conditions unless the glass is very seedy at the same time or unless the throat is so worn that the flow in the melter is largely on the surface. With the exception of the small amount of gas dissolved by the glass, all the refining must take place from the surface of the melter; while the main flow of glass, even in a flint tank, is along or near the surface, the movement of some of the glass at a depth greater than that which obtains in a tank of dark colored glass increases the possibility of some of the gas bubbles being carried to the throat before they have time to clear to the surface; on the other hand, the fact that nearly all of a dark colored glass moves along or near the surface prevents any gas bubbles being carried far below the surface at a distance from the throat; at the same time, the higher temperature obtaining through the depth of a flint glass tank allows more melting to take place below the surface than is the case with dark colored glass. As a dark colored glass has greater absorption powers for radiant heat, it is possible that the surface of such a glass tends to maintain a higher average temperature than does the surface of a flint glass under the same furnace conditions.

The flow in the refiners of glass tanks is more varied than that in the melters, owing to the greater variety of outlets from the refiner, and the variation in amounts of glass drawn through the separate outlets. There are, however, some factors which are common to most tanks and which have considerable influence on the lines of flow at this point.

Just as local temperature variations in the melter will alter the normal lines of flow at this point, similar variations in the refiner often have great influence on the lines of flow in the front of the tank. Glassworkers often notice that one side or one hole on the working end of a tank will run hotter than the opposite side or the corresponding point on the opposite side. These local temperature variations are at times the result of better regeneration on one side of the tank than on the other or of variations in the height or amount of baffle wall opening across the tank, but the most common and effective cause of these local variations lies in the presence of openings in the refiner.

As is well known, variations in the furnace pressure (brought about by varying the stack draft) have the greatest influence on the refiner temperature. The effect of a definite furnace pressure on the refiner temperature depends to a considerable extent on the amount of opening in the refiner, being much greater when the presence of openings, cracks, etc., allows flow of gas through the refiner wall and crown, than when the refiner is airtight. When the tank is operated under a definite pressure, increase in the amount of opening will cause an increase in the refiner temperature when the tank pressure is greater than atmospheric, and will cause a decrease in this temperature when the tank pressure is less than atmospheric; this is because such openings will cause an increased flow of hot gases from the melter to the refiner in the first case, and an increased influx of cold air in the second. The glass located near these openings and over which the streams of hot gases or of cold air flow will have a temperature higher or lower than the glass in the refiner distant from the openings, and in the first case will tend to flow more and in the second case less than this more distant glass.

A factor which has considerable influence on the lines of flow in the refiner is the temperature of the glass entering the refiner through a throat relative to that of the glass already in the refiner. When the incoming glass is colder or is near the same temperature as the glass on the surface of the refiner, the tendency is for the glass to go from the throat in the direction of the working openings; however, if the incoming glass is much hotter than that in the refiner, it goes directly upward, along or near the bridgewall, to the glass surface and there spreads out. The result of this type of flow can not only be seen in the lines of corrosion of the block on the refiner side of the bridgewall, but the flow itself is often readily visible in a welling up of the glass in the refiner directly above the throat opening. This type of flow is most common with dark colored glasses, especially when the pull is moderate or heavy and there is a considerable temperature differential between the melter and the refiner.

The flow of a dark colored glass from the melter surface downward to the throat and from the throat upward to the refiner surface may become relatively rapid under a high pull, as most of the flow here is confined to a small zone. In changing color or batch with a dark colored glass, this is of importance, inasmuch as much of the sloughing of the

old glass takes place here as a result of the cutting action of the hot rapid stream. Much less sloughing and streaking from a color change takes place when the change is made from a light to a dark color than when the opposite change is made, owing to the fact that the bottom glass is kept hotter and more fluid in the second case than in the first.

The flow of glass through tanks is seldom rapid enough to result in turbulent flow, especially in view of the high viscosity of glass even on the melter surface; the only instance of such flow the writer has ever seen was in a light green tank near the trough feeding an Owens machine making 5 and 12 gallon bottles and through which a very heavy flow of glass was maintained; the presence of turbulent flow at this point was evidenced by eddies in the block scum on the glass surface near the wall.

The use of skimmer blocks or of deep boots does not entirely prevent the flow of surface glass into the boot or trough; in fact, with dark colored glasses, and after the flow has been in progress for some time, nearly as much surface glass will be drawn without the skimmer as with it. With light colored glasses, the amount of surface glass drawn is less, but still considerable. When the flow is first started, the tendency is for most of the glass drawn under the skimmer or boot to come from the lower level, but as the flow continues, the surface glass moving more easily than that from below the surface, on account of the greater fluidity of the former, the amount of surface glass in the stream gradually increases up to a certain point, depending on the rate of temperature drop or of viscosity increase through the glass. Skimmer blocks are effective in holding back scummy glass, because such glass is more viscous than the clean glass below the surface.

The rounding out of the corners of the melter and refiner to give a stream line effect has at times been proposed, and practised to some extent in England. The object of this is to eliminate the accumulation of glass in the corners, which, by sloughing into the glass stream, might weaken the ware by giving a streak of glass which is of such a "nature" as to be mechanically weak. This would undoubtedly be of value in the case of colored glasses, but would not be effective unless accompanied by a decrease in the depth of tanks; in the case of flint glass, this would be of lesser importance, inasmuch as the temperature near the bottom of such tanks is usually high enough throughout to prevent the formation of this weak glass.

It would seem most logical that the depth of tanks at all points should be such that the glass near the bottom would, under normal operating conditions, have a temperature low enough to prevent any pronounced block attack, but also high enough to obviate the formation of any weak natured glass. This would necessitate the use of much more shallow tanks for dark colored glasses than is at present customary and would mean that the refiner should be more shallow than the melter.

Rounding off the corners of the surface of the melter would result in a decrease in the effective melting area of the tank, as some melting and refining takes place here. The glass on the surface near the corners of the refiner is not motionless, even if no working opening is located here. In a tank of dark green glass, from which four machines were drawing glass at an equal rate, the machines being located at equal distances from the bridgewall and from each other, pieces of block were placed at intervals across the refiner about a foot distant from the bridgewall and their movements observed. It was found that the pieces of block near the corners moved the most rapidly towards the machines, that in one corner moving very much more rapidly than any of the others.

The use of the throat helps greatly to prevent the effect of variations in refiner flow extending to the melter, but does not entirely overcome this effect, as is shown by the fact that a very heavy pull at one point in the working end will often draw unrefined or unmelted glass to that point, while the glass elsewhere at the working end will be clear and, although the total of such an uneven pull may be less than can be carried with clear glass on a uniform pull. There is little motion throughout the stream of glass flowing through the refiner and part of the melter, as is shown by the fact that scum or glass of a different color entering the stream at some point along its course will not usually spread throughout the stream, but will maintain the same relative position all the way to the working points.

DECORATED GLASSES BY HENRI NAVARRE

Henri Navarre of Paris, once a goldsmith and medal-maker, recently became an artist glassworker. The feature of his work lies in the use of glass in mass, tinted in the body of the glass itself with grains of mineral oxides arranged in irregular manner but with a particular diversity so as to form a decoration. This process produces pen-stroke effects of fine style, asserted with authority.

Surface Tension as a Factor in the Forming of Glassware

By Roy E. Swain[1]

When glass is allowed to cool from the molten to the solid state without coming in contact with anything other than the atmosphere, it has a very smooth surface. This surface is pleasing to the eye, does not soil easily, and is easily cleaned when soiled. The glassworker in obtaining the desired form or shape for the article, is always on the alert to prevent the molten glass coming in contact with anything unnecessary. He takes this precaution to insure the best surface possible for his wares. He is also constantly trying to devise new methods of working that are less severe than those now in use, as many of the glass working methods now in use are given preference in order to speed up production or lower costs rather than improve the quality of the ware.

When a small quantity of water is thrown on an oiled surface the water immediately forms itself in a number of

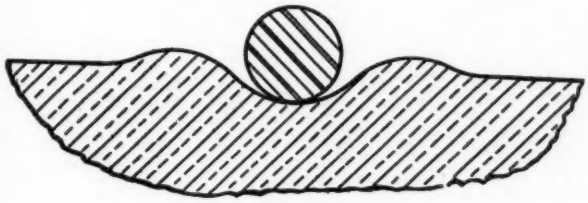

FIG. 1

spherical-shaped drops. While a similar experiment can not be tried with glass we have ample proof that molten glass possesses this property of surface tension to a remarkable extent. Soft glasses are sometimes attached to harder glasses as ices for decorative purposes. These ices stand out as beads somewhat like the water experiment described except in this case the ice wets the glass and if heated sufficiently will spread so that the beads join and form a continuous sheet. Should the furnaceman or gatherer lay a cold pipe or proof rod on the surface of the glass in the pot or tank it will make an identation similar to the sketch, Fig. 1. This may appear to be due to a layer of colder glass on the surface, but it will happen even when the surface glass is at a higher temperature than the body of the glass.

Another simple experiment that will show something of the strength of this tension: A small thread of glass fed down into a flame will as it melts climb the thread to form a bead on the end of the thread. When the end of a piece of tubing is heated in a flame the end will close as the glass softens. By feeding the tubing farther into the fire the tubing contracts in length. Lampworkers make use of this property of glass to build up a sufficient amount of glass to give the desired thickness to the walls of flasks made of tubing.

In fire finishing or glazing thin blown tumblers and similar articles this tendency to "cup in" becomes a source of trouble. Enough heat must be applied to melt the edge of the article and permit surface tension to destroy the sharp and uneven edges without changing the shape of the article.

In blowing very small flasks or bulbs it is sometimes necessary for the blower to swing the pipe vigorously in order to elongate the blank to the length of the mold, the surface tension overcoming gravity in its tendency to lengthen the blank.

The gatherer makes use of surface tension in shaping his gathering of glass. By "burning" his gathering in the pot or tank he is able to remove all traces of laps or threads. In the hard glasses this is necessary to prevent scars and unequal distribution in the finished ware. When working the softer glasses the gatherer may gather the glass quickly and break the thread outside the pot and the scar will immediately heal over.

Since surface tension will withdraw sharp projections and edges, it no doubt offers resistance to the formation of such, so may be blamed to some extent for our inability to secure sharp figures and designs on blown ware. This condition also exists to some extent in pressing. Thus it is possible to bridge over the vents and joints of the molds and leave but scarcely noticeable marks or seams on the surface of the ware. Press ware made in cast iron molds has a dull surface due to the coarse grain of the metal in the molds. Worn joints in the molds will cause unsightly seams or fins. These defects may be removed by fire finishing. The article is

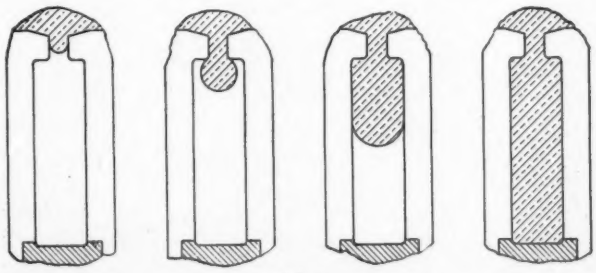

FIG. 2

placed in the fire just long enough to soften the surface and permit the surface tension to smooth out the irregularities.

In extruding glass through the gate of a font mold, or small orifice of a pulsating feeder, we have very good examples of the effects of surface tension. In the font mold where the well is over the forming cavity the mold fills from the top down. This is contrary to what one would expect. A series of sketches (Fig. 2) showing the development of the article has the appearance of having been drawn upside down, for the article develops just as though the gate was in the bottom of the mold and the glass was forced upwardly through the gate into the mold. We cannot see very well just how this happens but by partly filling the mold and opening

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it we can study the partly finished article in its different stages of development. In very large articles the ball of glass forming below the gate may not reach the side of the mold before surface tension is overcome by gravity. In this case the ball of glass falls to the bottom of the mold and the mold fills from the bottom up. Such articles will usually have laps and other surface defects.

One has a better chance to observe the effects of surface tension in studying the gob formations of a pulsating feeder. In some classes of ware it is essential that there be no shear mark. One method of making sure that the lower shear mark is burned out is to withdraw the depending glass into the bushing of the forehearth where it will reheat. When using small bushings this procedure will produce a ball-shaped gob as the glass extends itself almost equally in all directions as it emerges from the forehearth until gravity overcomes the surface tension and the ball of glass starts to fall away.

There are now on the market a number of light blown articles that are finished in the shop by "burning off" the waste glass. This ware has a beaded edge that is especially noticeable in the lighter walled articles. In finishing this ware the waste glass is suspended and a very narrow band at the finishing line is heated in an intense flame. This narrow band becomes so fluid that the waste glass falls away, the flame cutting through the thinning sheet and later healing any ragged edges. Surface tension can be given the credit for the smooth finish and beaded edge of this ware.

Free-hand glassware is remarkable for its easy curves and the absence of sharp corners or abrupt changes in contour. This is necessary as this method of working provides no means of forcing the glass to any great extent.

High grade optical glass is shaped from chunks of glass broken from large masses of specially prepared glass. To save grinding and material these irregular shaped chunks of glass are reshaped to approximately the shape and size of the finished article. This is done by heating them in a furnace to the softening point and reshaping by paddling or otherwise. Just as the glass begins to soften it may be attached to a punty and by manipulating it in a flame it will become a compact mass that can easily be molded to the desired shape. Not long ago there was a fad for making lamp shades and other novelties and covering them with small glass beads. We were told that these beads were "imported from Europe" and "made by a secret process." Obtained from different sources these beads varied considerably in character and quality. Some may have been made by tumbling small bits of glass with abrasive, followed by polishing. This would be a rather tedious process. The greater proportion of these beads appear to have a fire finish. These were probably made by sifting small particles of glasss down through a melting atmosphere. Small particles for such work may be made by disintegrating "snappers" or "Prince Rupert's drops." Small bits of glass secured in this manner resembled grains of sea sand as they do not have the sharp edges and needle like projections of crushed glass.

Many methods and treatments have been devised for decorating glassware but good glass carefully made does not depend upon the decorator's art to make it beautiful. The beauty that lies within good glass can best be appreciated only when the article has a high grade surface finish. The most desirable finish in this respect is the natural fire finish, obtained by permitting the glass to congeal or set without coming in contact with anything other than the atmosphere. This finish owes its beauty to the surface tension of molten glass. Drawn glass cane and tubing owe much to surface tension for their perfect circular cross section and all drawn glass receives its beautiful finish from this source.

The glass worker may not be able to measure surface tension and at times may be at a loss to determine just what part it plays in certain operations but experience has taught him its existence and many ways of using this property of molten glass in the performance of his duties.

Physical and Chemical Properties of the System—Soda—Potash—Lime—Alumina-Silicate

BY DR. E. BERGER, JENA[1]

Glass science is primarily interested in the question as to which melts possess the least tendency to crystallize, or, to express it in positive terms, which melts possess most prominently the properties belonging to the glassy state of matter. Science also desires to know the properties of these glasses. Experimental work on these problems carried on by various investigators is difficult to tabulate, since little has been done, and because the experiments have been conducted with different objects in view. This paper contains the results of systematic investigations of the system, indicated by the title, as part of the long series of experiments, made in the Jena Glass Works Schott & Gen.

The method of investigation was first outlined, describing the type of furnace used, the melting process, the measurement of refraction, dispersion, density, expansion, durability, etc., and a study of the glassy properties. In this connection a number of glassy, transparent stones were exhibited, such as occur in fused boric acid, and also round transparent disks. The results of the investigation were shown in the form of curves, indicating the limits of the glassy, the semi-glassy and the completely crystalline states. Curves indicating similarity of properties were also exhibited.

The properties were represented in a four-dimensional diagram, showing that this mode of presentation has the advantage of greater economy and more precision. The results showed that in the system, mentioned above, the refraction, density, and expansion are additive properties. The glassy property and the durability are not additive.

Finally the accuracy of the experimental work was discussed and the future field of investigation was outlined, necessary to obtain an adequate conception of the glassy state of matter, based upon the constitutional properties.

Manganese Producers Association Organized

The American Manganese Producers Association was recently organized at Washington, D. C., with J. Carson Adkerson of Woodstock, Va., as president.

[1] Abstract of a paper presented at a meeting of the German Society of Glass Technology at Weimar.

Progress in Gas Producer Practice

By Wm. B. Chapman[1]

"You can do it *better* with gas" is a true advertising slogan. It is also true that you can do it cheaper with producer gas. This is particularly so when the gas is used hot and conducted to the furnace without undue loss of sensible heat.

Of all the commercial gases there is but one—producer gas—that is adapted to be used hot, raw and unwashed. It is for this reason that producer gas stands supreme as the most ecnomical heating medium for ordinary furnace purposes.

Modern gas producers are fully 90% efficient when the sensible heat of the gas is utilized, and about 80% efficient when the sensible heat is lost, as when the gas has to be conducted a long distance or when the gas is washed. The net efficiency of washed gas, however, is nearer 70% because of the loss in operating the washing equipment and the additional amount of steam required in the blast. It is for this reason, together with the objectionable cost of the washing equipment, that over 90% of all producer gas installations are for hot, raw gas, just as it is made.

The gas producer and the regenerative furnace were invented about ninety years ago and developed simultaneously, each making the other possible. The greatest contribution to the art was made by Siemens Brothers of England, starting about 1835 and continuing actively for over forty years. No other signal contributions have been made to the art except by Ritter VonKerpely of Donawitz, Austria, inventor of the first successful mechanical producer in Europe and W. E. Hughes inventor of the first successful mechanical producer in the United States. The outstanding contribution of these two gentlemen at the beginning of the present century made possible the work of others who collectively have finally succeeded in putting the gas producer on a reliable mechanical basis that compares favorably with other mechanical equipment in the plants where used.

Requirement for Large Furnaces

All large heating operations require a form of fuel that is easily controlled so that the heat may be distributed as desired throughout the furnace. This requirement is impossible to meet when solid fuel is burned upon a grate. A mechanical stoker provides a little agitation and some degree of uniformity but it is insufficient. The ordinary mechanically stokered fire bed is far from uniform in thickness, in temperature and in density. Our conventional stokers are well adapted to a few special fields of heating but they do not offer a broadly applicable solution to the general problem of utilizing fuel economically. We must search elsewhere.

Fuel Oil

Fuel oil does not solve the problem of heating large furnaces economically for in most cases it costs 2½ times as much as coal. For example fuel oil usually costs about 1c. a pound (7½c. a gallon) and bituminous coal costs about ⅛c. a pound ($4.00 a ton). One cent will, therefore purchase 18,500 B.t.u's in the form of fuel oil, or about 60,000 B.t.u's (5 × 12,000) in the form of coal. However, for proper comparison one should add at least 2c. per gallon to the cost of fuel oil to cover overhead charges, which are largely made up of the cost of compressing the air required for atomizing. And $2.00 per ton should be added to the cost of the coal to cover the total cost of gasification, including all overhead charges if standard equipment is used. (Recent experiments, however, on a large scale indicate that it will not be long before this charge can be reduced to considerably less than $1.00 per ton.) Adding to the assumed cost of $4.00 per ton for coal the maximum estimate of $2.00 per ton additional for gasification and investment charges for producer gas, gives a total of $6.00 per ton. One cent will then purchase 3.6 pounds or 43,200 B.t.u. From this figure we should deduct 15% for losses in generating the gas and conducting it to the point of consumption, leaving 36,720 B.t.u.'s net available for 1c. in the form of hot unwashed producer gas. Now, adding to the assumed cost of 7½c. per gallon for fuel oil an additional 2c. per gallon for handling and atomizing, including overhead (and it usually amounts to more than 2c.) gives 9½c. per gallon and assuming 18,500 B.t.u's per pound gives 14,600 B.t.u's net available for 1c. in the form of fuel oil. This makes fuel oil practically 2½ times as expensive as producer gas. As a rule only small or special installations of fuel oil are justifiable. We cannot look to this form of fuel to produce heat at low cost in our large industrial centers.

Pulverized Coal

The possibilities of pulverized coal as a solution to the cheap fuel problem are interesting, but they have not as yet been fully determined. This form of fuel has shown remarkable efficiencies in burning cement and lime, in boiler heating and in many high temperature operations, but the ash content of pulverized coal has caused such serious trouble with the furnace linings and the goods to be heated that, in many cases, if not indeed most cases, the advantages have been largely offset by the disadvantages. The cost of pulverizing usually runs from 35c. to 75c. a ton when all overhead expenses are included.

Fuel Burned in Suspension

The advantages of burning pulverized coal and the advantages of burning fuel oil are somewhat similar and largely arise from the fact that both can be burned in suspension. In other words they "burn like gas" and partake of the advantages of a gaseous fuel. If a fuel can be burned in suspension it can be conducted to any point and burned at any desired rate. In burning fuel upon a grate one is limited to a thin fire-bed, usually less than a foot thick. If it were deeper it would make producer gas. When a thin fire-bed

[1] President, Chapman Engineering Co., Mt. Vernon, Ohio. This paper presented at National Meeting of the A.S.M.E. Fuels Division, St. Louis, October 10-13, 1927.

is forced, much uncombined air escapes up through the bed and thereby considerably reduces the furnace efficiency, but when fuel is burned in suspension it is like increasing the depth of the firebed, which greatly reduces the amount of excess air required. When producer gas is burned the "fire-bed" or combustion zone, instead of being one foot in depth, is increased to ten or twenty feet in depth if desired and the excess air, instead of being 50% to 150% is reduced to between 5% and 15%, provided the fuel is uniform in quality and accurately controlled in quantity.

In putting forward the economic possibilities of producer gas and its claims for more consideration as a universal fuel, the author will not discuss natural gas, coke oven gas, or the electric furnace. The logical use for natural gas and coke oven gas is for domestic consumption. These gases are too valuable to be substituted for producer gas except in isolated steel plants requiring a large amount of coke for their blast furnaces and unable to sell their coke oven gas because of the distance it would have to be pumped to a domestic market. The excessive cost of operating electric furnaces limits their use to special applications where the cost of fuel is secondary.

Hence we have four outstanding types of fuel for conducting large heating operations: (1) coal burned upon a grate, (2) fuel oil (burned in suspension), (3) pulverized coal (burned in suspension) and (4) producer gas (burned in suspension).

It is not likely, at least in the near future, that coal burned upon a grate or atomized fuel oil will develop new and hidden possibilities of great value. Apparently we must look to pulverized coal and producer gas for future progress in the economical use of fuel in large units for general purposes.

Pulverized coal, if it can be applied without serious detriment to the furnace or the goods to be heated, usually possesses the important advantage of fuel economy. Its application to cement burning stands unchallenged. But for most large heating operations producer gas possesses the greater number of advantages and is most widely applicable. In the past producer gas has had the disadvantage of requiring a considerable amount of skill and zeal on the part of the gas maker in order to maintain satisfactory quality and uniformity. Since producer gas is not stored but made as used and used as made it will never be quite as uniform as water gas or illuminating gas which require large gas holders where the quality is accurately blended to within less than 1% of an established standard. Such a degree of uniformity is unnecessary. The other short-coming of producer gas is that the gas flues have to be made excessively large and require cleaning every week. In most plants this cleaning is a real nuisance.

The purpose of this paper is to point out the progress that has been made in recent years in overcoming these two hitherto serious objections to the use of producer gas, and to suggest to this First National Fuels Meeting that more attention be given to the problem of unlocking the possibilities of this cheap type of fuel for use in other fields than the conventional ones to which it heretofore has been limited.

When one undertakes to devise a machine for doing automatically work that was formerly done by hand he is apt to think in terms of the old hand movements and imitate them as best he can, never realizing that mechanical power frequently makes possible an entirely new solution to the problem. This has been the case with the gas producer. The first mechanical producer in this country had an enormous mechanical poker or stirring finger which imitated hand-pokers. Later developments in the art made by others substituted a mechanical rake or leveler which obviated the large vertical gap or recess made by the poker. By the use of machinery effective agitation from beneath the fire bed was also made possible. This marked an important advancement.

Most of the trouble in a fire-bed starts with chimneys or high temperature stream-lines. If allowed to continue, they develop into blow holes, the quality of the gas is lowered and clinkers are formed. These hot spots in a gas producer are caused by lack of uniformity in one or more of the following operations: (1) feeding and spreading the fuel, (2) agitating the entire fire bed, (3) removing the ashes. These operations are now being performed automatically with a considerable degree of uniformity.

The chief requirement of any fire-bed, and incidentally the condition most difficult to maintain, is uniformity. Each horizontal zone should be uniform in temperature, and above all, uniform in density. It follows therefore that the best producer is the one that automatically maintains the greatest degree of uniformity, and conversely the worst producer is the one in which it is most difficult to maintain uniformity. By this standard producers should be judged and not by some phenomenal showing made in an isolated test.

Automatic Feeds

In regard to feeding the fuel into the producer, all mechanical producers for bituminous coal in this country are now provided with some form of continuous feed. The automatic feeds employed by the Wellman, the Morgan and the Wood producers all drop the fuel upon a comparatively small sector of the fire-bed and then revolve the entire fire-bed beneath the feeding drum. In the Chapman feed the coal is dropped simultaneously over the entire fire-bed, thus obviating the tendency toward an uneven and spotty top temperature and the necessity of revolving the entire fire-bed. In all of the above types the coal is dropped at frequent intervals from a revolving drum. This tends to drive off the volatile matter in the coal at a uniform rate and thus saves about 10% of the fuel.

Surface Agitation

In regard to spreading the fuel after it has been dropped upon the fire-bed and breaking up masses that tend to cake or stick together: This function is well performed in the Morgan producer by a swinging U tube that rests upon the fire-bed in approximately a radial line, when the top of the fire-bed is at normal height. In the Wellman and the Wood producers a vertical or semi-vertical swinging poker is employed to spread the fuel and break up the tendency to cake. This poker or stirring finger extends to within a few inches of the ash line if the fire is at the correct height, and agitates the fire-bed nearly to the bottom. With this type of agita-

tion it is imperative that the ash line be kept at a substantially constant height, as otherwise the agitation of the lower portion of the fire-bed would vary considerably.

The Chapman Producer

In the Chapman Producer separate agitation is employed for the top and bottom of the fire-bed. The top agitator floats in the surface of the fire-bed and has staggered teeth extending downwardly about 10". The bottom agitator operates in the ash bed and has staggered teeth extending upwardly about 10". It has been found that the bottom of a gas producer fire-bed requires but little agitation (although it needs that badly) while the top requires frequent raking to properly spread the fuel and prevent caking. In the Chapman producer the top agitator makes one revolution in about 7 minutes and the bottom agitator one revolution in about 2 hours. The amount of agitation from both above and below is adjustable.

The ash removal in the Chapman and Wellman and the Wood producers is substantially continuous, which tends to make a uniform ash bed for the fire to rest upon. In the Morgan producer the ashes are removed automatically two or three times a day and the operator pokes the fire down during the ash removal period. Each method has special points of advantage. Producers that revolve the fire-bed have walls that taper-in considerably at the bottom; those that do not revolve the fire-bed have straighter walls.

It is the author's belief that eventually all producer manufacturers will provide both top and bottom agitation. The agitation given the lower portion of the fire-bed will be much less frequent and less drastic than the motion at the top. The fuel will be fed continuously and the ashes removed continuously or substantially so. Furthermore, the pressure of the gas in the main will be kept uniform, the ratio of air to steam in the blast will be kept uniform and the temperature of the gas leaving the producer will be kept uniform. These things are now practically all being done as a matter of standard practice in some gas works, and a start has been made in their adoption in other lines.

(To be continued)

Spectral Characteristics of Light Sources and Window Materials Used in Therapy[1]

By W. W. Coblentz[2]

Before discussing the topics mentioned in the title of this paper it is relevant to comment on the present activity in physiotherapy, especially in the promulgation of the use of thermal radiant energy (as differing from high frequency electrical stimuli) in the treatment of disease. In order to promote the sale of merchandise little points of advantage are oftentimes emphasized to the exclusion of the more vital and essential ones. As a result, the layman, and even the physician, is sometimes confused regarding the properties of the device he is using. For instance, the so-called "violet ray" apparatus is not a source of ultraviolet rays worthy of the name; but it is a high resistance in the form of an evacuated glass bulb which shields the body from the intense electric current of the induction coil. The resultant muscular contraction from such a stimulus is a physiologic phenomenon entirely different from that of biochemical reaction that would be produced by the "violet rays" within the glass bulb electrode if these rays were generated in sufficient intensity and could escape through the glass walls of the bulb.

Another example is the radiant heater, consisting of a resistance unit heated to incandescence at the focus of the reflector. It is true that the gap between the longest heat waves and short electric waves has now been bridged. But there is a vast difference in the penetrating power of the various wave-lengths, and it is not necessarily true that because electric waves "penetrate everything" that the same is true of heat rays.

In passing it is instructive to note that the shortest, "hard" X-rays and the longest radio waves are deeply penetrating. It is, therefore, of interest to summarize what we know about the transparency of the skin, blood, etc., to radiation of various wave-lengths throughout the spectrum.

Regions of the Spectrum Under Consideration

The successful use of light in therapy will depend upon a thorough understanding of the physical properties of the source of thermal radiation, as well as the physiological reaction of living matter when exposed to it. Excepting the question of intensity and wave length, physically there is no marked distinction between the various regions of the spectrum called "ultraviolet," "visible," or "infra-red."

Chemically and *physiologically* there is a distinct difference. The action of infra-red rays is thermal and instantaneous, producing a burning sensation when the intensity is too great. On the other hand, the ultraviolet rays are actinic; that is, they cause the precipitation of albumin. Their action is slow and insidious, so that the effect is not perceived until some hours after exposure. A short exposure to an innocent looking carbon or mercury arc may produce severe conjunctivitis. Hence, the eyes should be protected with deep brown glasses or covered with a black cloth to prevent injury when the body is being irradiated.

For convenience we shall mark these spectral ranges and mention some of the photochemical and physiological effects, if known. The wave-lengths are written in millimicrons, $m\mu$; that is, wave-length 300 $m\mu$ = 3,000 Angstrom Units = 0.3 μ.

(a) FAR ULTRAVIOLET, 180 to 290 $m\mu$: Oxygen has an absorption band in the ultraviolet at 170 $m\mu$. The absorption is so intense that in the laboratory the practical limit of the ultraviolet is about 180 $m\mu$. The much longer column in the earth's atmosphere, even at high altitudes,

[1] Abstract of paper presented before the Twenty-First Annual Convention of the Illuminating Engineering Society, Chicago, October 11, 1927.
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absorbs all the sun's rays in wave-lengths less than about 290 $m\mu$, and even at 300 $m\mu$ the intensity is very weak. For example, the intensity at 290 $m\mu$ is only $\frac{1}{100{,}000}$ that at 302 $m\mu$, and one-millionth the intensity at 314 $m\mu$. This part of the ultraviolet spectrum is easily produced by some of our artificial sources, but it is entirely absent in sunlight. The arc between electrodes of nickel, aluminum and iron, also these metals in the arc of cored carbons, the mercury arc in a quartz burner and the high potential spark between electrodes and magnesium, of zinc and of aluminum, are rich in ultraviolet rays of wave-lengths 180 to 300 $m\mu$.

Whether it is by coincidence or owing to the fact that the human skin, germs, etc., have not become accustomed to these rays because they are absent in the sunlight, it is well known that the rays of wave-lengths 180 to 300 $m\mu$ have a rapid germicidal action and that they easily irritate the skin. This is especially true to the untanned, unpigmented skin,—blondes being especially susceptible.

These rays cannot penetrate deeply into the skin (probably not much deeper than 0.1 *mm*), which like many other materials, especially when slightly colored, is quite opaque to short wave-length, ultraviolet radiation. In my tests a layer of epidermis 0.03 *mm* in thickness was found to be entirely opaque to ultraviolet radiation of wave-lengths less than 300 $m\mu$, but it was fairly transparent to the visible rays—in agreement with Hasselback and others.

The action of these rays may be photochemical, just as it is in the activation of food, producing in the blood stream an active substance that has the same function as activated food in the prevention of rickets.

Although the intensity of these rays is small, relative to the total amount emitted by various light sources, it is well known that they have a very rapid action in coagulating albumin. Using the same amount of infra-red radiation, it would be necessary to "cook" the albumin a long while in order to produce the same amount of coagulation.

While the rays in this spectral region have a strong destructive (abiotic) action, there is no sharp demarcation between them and the adjacent spectral range (290 to 365 $m\mu$), in which the germicidal action is much slower.

(b) NEAR ULTRAVIOLET, 290 to 365 $m\mu$: In the spectral region of 290 to 315 $m\mu$ the solar radiation at sea level, during the noon hours, amounts to about 3 per cent of the total incoming rays. The range of 290 to 320 $m\mu$ has been called the "Health Giving Rays" or the "Vital Rays." It is not known to me how sharp this demarcation was established, for it really does not exist. Perhaps it is owing to the fact that window glass is opaque to rays shorter than about 320 $m\mu$, and that sunlight, filtered through window glass, is deprived of most of its germicidal power.

Table I.—Summarizing the Different Spectral Regions, the Probable Depth of Penetration and the Probable Physiologic Action of the Rays from Different Sources.

Spectral Region	Penetration of Rays	Physiologic Action	Sources
Far ultraviolet 180 to 290 $m\mu$	Superficial 0.1 to 0.3 mm.	Photochemical	Metals in carbon arc and spark of metals (mercury arc)
Near ultraviolet 290 to 365 $m\mu$	do. 0.3 to 0.5 mm.	do.	Sun. Metals in carbon arc, arc of metals
Visible spectrum 390 to 760 $m\mu$	do. 1 to 5 mm.	Thermal; nerve stimulation	Sun. Carbon arc
Near infra-red 760 to 1500 $m\mu$	Deep 10 to 30 mm.	do.	Sun. Carbon arc. Gas-filled tungsten lamp
Far infra-red 1500 to 15000 $m\mu$	Superficial 3 to 0.1 mm.	do.	Carbon arc, infra-red (radiant) heaters

But some germicidal power has been produced by sunlight transmitted through glass. Moreover, Coblentz and Fulton[3] obtained germicidal action with the strong emission line at 365 $m\mu$ in the mercury arc. However, the action was found to be much slower than that of the rays of wave-lengths extending from 180 to 310 $m\mu$.

This is, no doubt, the region of the solar spectrum that has the greatest therapeutic action, especially at sea level. The region of 290 to 310 $m\mu$ is very effective at an altitude of 7,000 feet, and, in going from 7,000 feet to an elevation of 11,000 feet (as I have observed at Flagstaff, Arizona), the ultraviolet has a very rapid effect, causing erythema and in tanning the skin.

(c) VISIBLE SPECTRUM, 390 to 760 $m\mu$: The therapeutic action, if any, of these rays (and of the ultraviolet spectrum between 365 and 390 $m\mu$) is largely undetermined. They are present in great abundance in daylight. The penetration into the blood stream cannot be very deep (0.5 to 1 mm.), though in certain parts of the body (e.g., in the abdominal region) it is probable that the rays penetrate to the depth of 3 to 5 mm. or perhaps even deeper. The physiological action is probably thermal by dilation of the capillaries and the stimulation of the nerve endings.

(d) NEAR INFRA-RED, 760 to 1,500 $m\mu$: It is well known that water in thickness of 2 to 3 mm is opaque to radiation of wave-lengths longer than 2,000 $m\mu$, and in thickness of 10 mm., it is entirely opaque to wave-lengths longer than 1,400 $m\mu$.

By reflection and scattering of the rays by the red corpuscles, some radiation of wave-lengths at 650 $m\mu$ enters the blood stream. Hence, we conclude that the rays of the wave-lengths of 760 to 1,500 $m\mu$ (or perhaps to 2,000 $m\mu$) are the only ones that can penetrate deeply into the blood stream. The psysiological action in phototherapy is probably thermal by action on the nerve centers rather than photochemical, as obtains in the short ultraviolet rays.

(e) FAR INFRA-RED, 1,500 to 15,000 $m\mu$: Thermal radiation of wave-lengths greater than 15,000 $m\mu$ are emitted by radiant heaters, but for therapeutic purposes the long wave-length limit may be placed at this value. It seems certain that radiation of wave-lengths 2,000 to 4,000 $m\mu$ cannot penetrate more than a fraction of a millimeter into the skin. The physiological action is probably thermal (by stimulation of the nerve endings in the skin), instead of photochemical.

The earth's atmosphere transmits practically no solar radiation of wave-lengths greater than 4,000 $m\mu$; likewise, glass bulbs enclosing the incandescent filament are opaque to wave-lengths greater than 4,000 $m\mu$. However, this lack is

[3] Coblentz and Fulton, Bureau of Standards Scientific Papers (No. 495) 19, p. 641; 1924.

well supplied by electric heaters. Red glass screens can be used for transmitting radiation of wave-lengths 800 to 4,000 $m\mu$. It remains to be proven that such narrow spectral ranges of infra-red radiation are advantageous for therapeutic purposes.

Therapeutic questions cannot be settled in the physicist's laboratory, but the physicist can prove that these rays of long wave-lengths cannot penetrate deeply into the blood stream. Hence, the alternative is to conclude that the physiological effect must be produced by some reaction (on the nerve centers and blood vessels) near the surface of the body.

[*Various sources of radiant energy are then discussed, including the sun, the carbon arc, the gas-filled tungsten lamp, the quartz mercury arc, the nickel and the tungsten arc, radiant heaters and miscellaneous sources. The results are summarized in Table II.*]

Our recent measurements (April, 1927) show that at the noon hours the average window glass shuts out 2 to 3 per cent of the total radiation of the sun, consisting of short wave-length ultraviolet rays that are known to have therapeutic value in the prevention of rickets. The energy equivalent of these short wave-length ultraviolet solar rays, obstructed by window glass and amounting to 2.5 per cent of the total incident energy (1.2 to 1.4 gr. cal.) is about 0.03 gr. cal. per cm^2 per minute. From this it appears that, in order to obtain the best results, it is desirable to use a window glass that transmits the maximum amount of the short wave-length ultraviolet solar rays. This is possible only by choosing a glass having a high transmission at 290 to 310 $m\mu$.

Full sunlight may be rather strong dosage, at least for weak patients. If we tentatively adopt one-third full sunlight (2500 to 3000 foot-candles) as an average *unit of dosage*, the ultraviolet component of therapeutic value (the part obstructed by window glass) is about one per cent of the total unobstructed incident solar radiation, or about 0.01 gr. cal. per cm^2 per minute.

Windows for Solariums, Dwellings, and Enclosing Units

In view of the fact that, as a rule, only the hands and face are exposed to light, it does not seem urgent to replace our house and office windows by the expensive new glasses that have a high transmission of the short wave-length ultraviolet rays. It probably would be cheaper, easier and more effective to take a lightbath by exposing the body to the radiation from a mercury or carbon arc lamp for 5 or 10 minutes before dressing in the morning.

However, the usefulness of such glasses for windows of solariums, sun parlors in hospitals, etc., where the nude or partially nude body can be exposed is admittedly an important forward step in light-therapy. The investigation of the biological effects resulting from the use of such substitutes is a problem under investigation by physiologists.

Progress in the production of glass having a high transmission of ultraviolet radiation is so rapid that it would be hazardous to make predictions. A few years ago the only medium available for windows transmitting short wave-length ultraviolet solar radiation shut out by window glass was fused quartz at prices that prohibited extensive use even in sanatoriums, hospitals, etc. Now we have new glasses and glass substitutes ranging from material that is but little better than window glass to the better grades, such as "Vio-ray," "Bretlet" and "Vitaglass," which transmit 40 to 60 per cent of the short wave-length ultraviolet rays (the so-called "Vital rays") that are absorbed by window glass; and finally we have the "Corex" glass which transmits 90 to 92 per cent of these so-called "Vital rays." From this standpoint "Corex" may be considered the perfect glass, in that all glasses, including fused quartz, reflect about 8 per cent of the incident light and, hence, the maximum possible transmission is about 92 per cent of the incoming activating ultraviolet solar rays. The main question now is the cost, but with the development of trade we may expect a material reduction in the prices of these new glasses.

With the advent of these new glasses, which are easily kept clean, the glass substitutes, consisting of a film of cellulose on a wire mesh, need no longer be considered for sanatoriums, although it is true that they eliminate the hazard of injury from breakage, and that, when the cellulose is new, the material is more transparent than window glass in the spectral region of 290 to 310 $m\mu$. In greenhouse cold frames, and in animal houses, where there is frequent breakage of glass, the cellulose substitute is useful.

One argument, sometimes used for placing these new glasses in windows having a north exposure, is that the

TABLE II.—GIVING THE RADIANT FLUX IN WATTS PER CM^2 AT A DISTANCE OF 1M. FROM THE CENTER OF THE ARC, AND THE SPECTRAL RADIATION COMPONENTS IN PER CENT OF THE TOTAL TO 12,000 M (FROM TABLE 2 OF B. S. SCIENTIFIC PAPER NO. 539).

Source of radiation	Thickness of electrode in mm	Amperes	Watts per square cm	Spectral component in per cent of total to 12,000 $m\mu$: 180 to 310 $m\mu$	310 to 370 $m\mu$	370 to 480 $m\mu$	480 to 600 $m\mu$	600 to 1400 $m\mu$	1400 to 4200 $m\mu$	4200 to 12000 $m\mu$
Sun, sea level, (Washington)			(125 gr. cal.) 0.088	2.0	2.8	12.6	21.9	38.9	21.4	0.4
Sun, 7000 ft. elevation (Flagstaff, Ariz.)			(1.65 gr. cal.) 0.115	2.2	3.1	12.5	22.1	37.7	22.0	0.6
Quartz Mercury arc		4	.0026	5.7	2.8	2.5	6.7	3.2	20.5	58.6
Gas filled tungsten lamp		12.7	.0125	0.0	0.2	1.0	3.8	29.8	54.2	11.0
Neutral core carbon	6	5	.0011	0.2	0.3	0.8	0.7	16.1	61.1	20.8
Neutral core carbon	12.7	26	.0365	0.4	1.1	4.4	1.3	13.9	58.7	20.2
(Dochtkohle)	7	10	.0028	0.3	0.4	2.2	3.6	23.3	59.5	10.7
Nickel core	6	10	.0019	1.0	1.1	2.0	2.1	21.4	57.2	15.2
Nickel core	10	29	.0332*	2.6	3.1	3.9	2.3	12.0	54.3	21.8
White flame	10	10	.0055	1.4	2.2	3.4	5.7	10.9	48.3	28.1
White flame	10	20	.0121	2.9	1.5	10.0	6.7	14.3	39.3	25.3
White flame	12.7	30	.0430*	2.1	2.0	9.0	9.8	19.5	39.2	18.4
White flame	12.7	90	.0490*	1.6	4.7	17.7	11.5	24.5	33.5	6.5
Blue flame	10	16	.0054	1.1	1.2	2.9	1.2	8.3	51.8	33.5
Blue flame	12.7	29	.0330*	3.1	2.3	5.2	1.5	11.9	52.1	24.0
Yellow flame	12.7	30	.0368*	2.6	1.6	3.2	20.9	12.2	40.2	19.3
Red flame	12.7	30	.0358*	1.1	2.0	4.0	12.8	24.1	39.7	16.3

north sky is rich in ultraviolet rays. This is true to some extent, but it is important to notice that the total amount of daylight, and, hence, of ultraviolet coming through a north window is very much less than direct sunlight.

Window Glasses

The data on glasses and glass-substitutes were obtained with the assistance of Mr. R. Stair, and are taken from an unpublished manuscript on this subject.

QUARTZ-LITE AND AMERLITE: The ultraviolet spectral transmission of *Quartz-Lite*, also *Amerlite* glass, which is of recent production, show the rapid development of new glasses that are somewhat more transparent to ultraviolet than ordinary window glass. Part of the greater transparency in many of these new glasses is obtained by using material that is considerably thinner than window glass. This increases the breakage hazard and, hence, in solariums it is desirable to design the sash to meet the safety requirements.

The various samples examined transmitted but little more than a sample of window glass. The transmission at 303 $m\mu$ ranged from 1.8 per cent, for a thickness of 1.4 mm., to 0.4 per cent, for a thickness of 1.9 mm. From direct measurements on solar radiation it was estimated that this type of glass, as now made (July, 1927), transmits about 5 per cent of the short wave-length ultraviolet rays of sunlight absorbed by average window glass (see Fig. 1).

The infra-red transmission is high, like window glass, at 3,000 to 4,500 $m\mu$. However, a high transparency is unimportant in view of the fact that solar radiation is extremely weak in this part of the infra-red spectrum.

VITAGLASS: The best samples have a fairly high transmission (20 per cent) at 280 $m\mu$ in the ultraviolet. The infra-red spectral transmission of *Vitaglass* is relatively high at 3,000 to 4,500 $m\mu$.

Tests made at sea level during the middle of the day in April, May and June show that *Vitaglass* transmitted 50 to 60 per cent of the total ultraviolet activating solar rays which are absorbed by ordinary window glass. It will, of course, be understood that still higher transmission values would be observed through all these glasses when the air mass is greater than $m = 1$; that is to say, when the ultraviolet vitalizing rays are decreased by atmospheric absorption (see Fig. 1).

COREX GLASS, G. 980A: The ultraviolet transmission of a newly developed colorless glass, *Corex*, exceeds all other glasses yet examined and rivals quartz in transparency in the spectral region of 260 to 300 $m\mu$.

Tests made at Washington at the noon hour in summer showed that *Corex, G 980A* transmitted 91.4 to 91.8 per cent of the total ultraviolet solar rays which are absorbed by window glass. Correcting for reflection from the surface of the sample, the transmission would be 100 per cent, showing that this type of glass is optically transparent in this spectral region.

For therapeutic purposes, as regards transparency to ultraviolet rays, as already stated, this may be considered the perfect glass in that all glasses reflect about 8 per cent of the incident light and, hence, the maximum possible transmission is about 92 per cent of the incoming ultraviolet solar rays.

The transmission of Corning G 980A is high throughout the infra-red to 2,000 $m\mu$, beyond which wave-length it abruptly becomes very opaque, as previously observed in Pyrex glass.

ULTRAVIOLET FILTERS: Presumably, by dissolving coloring matter in glass G 980A, several remarkable filters for transmitting ultraviolet radiation are produced. Viewed in daylight, Corning glass G 984B has a light-green color, while the glasses G 985B and G 986A appear purple colored. They offer a ready means for isolating ultraviolet radiation for biological and other investigations.

Unfortunately, as yet no screens have been produced which absorb all the infra-red. By using a cell of water much of the infra-red transmitted by these glasses is eliminated.

UVIOL AND VIORAY GLASS: Some years ago Schott of Jena produced a new glass, *Uviol*, which is transparent to ultraviolet radiation of wave-lengths shorter than transmitted by window glass. No attempts seem to have been made to commercialize this product until recently, when we examined a similar material under the trade name *Vioray*. The ultraviolet transmission (Fig. 1) of the samples examined was not quite so high as some of the best grades of Vitaglass.

Owing to the fact that slight contamination from the gas burners, pots, etc., has a great effect upon the ultraviolet transparency of all of these glasses, a rigid control of the various melts is necessary in order to produce a glass having a high transmission.

As indicated in the earlier part of this paper the ultraviolet rays at 290 to 310 $m\mu$ have a more rapid biologic action than the rays of wave-lengths longer than 310 $m\mu$. Hence, biologists desire to utilize to best advantage this short wave-length solar radiation, however low in intensity. To accomplish this it is necessary to use a window glass having a fairly high transmission in this spectral region.

This is illustrated in Fig. 1 in which curve A gives the ultraviolet spectral energy distribution of the sun at sea level. This curve is the composite of the results (. . . . .) obtained by Fabry and Buisson by photography, and the results (x x x) of Abbot and his assistants at Mt. Wilson by spectroradiometry (Smithsonian Physical tables, air mass $m = 4$). In this same illustration, curve B gives the solar spectral energy remaining after transmission through a window of quartz glass or Corex glass; curve C through Vitaglass; curve D through Quartz-Lite and Amerlite; curve E through an average sample of window glass (thicker than the preceding glasses).

Integrating the areas under these curves between their termination in the extreme ultraviolet and, say, 315 $m\mu$ (the termination for window glass 3 mm. in thickness) we find the results in good agreement with our radiometric measurements showing that the best glasses transmit 90 per cent, while the poorest glasses transmit but little of these vitalizing rays which are shut out by window glasses.

Judging from the published biological results and from

the transmissive properties of organic and inorganic substitutes for window glass, it appears that, until biological experiments demonstrate that a lower transmission will answer the purpose, a fair and reasonable requirement is that the substitute for ordinary window glass (whether composed of

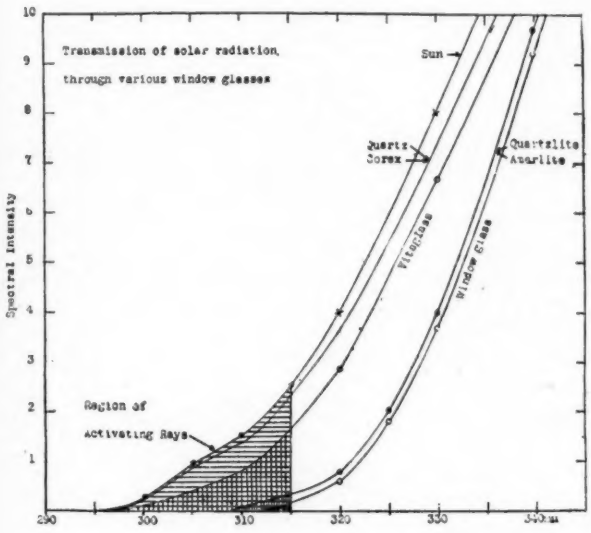

FIG. 1

organic or inorganic material) shall have a transmission of not less than 10 per cent of the incident radiation at the wave-length 290 $m\mu$, and not less than 30 per cent at the wave-length 310 $m\mu$.

Solarization of Ultraviolet Transmitting Glasses

All of the new glasses for transmitting the vitalizing solar rays at 290 to 310 $m\mu$ have been found to decrease in transmission of these rays after exposure to ultraviolet radiation. This decrease in transmission is of the same nature whether exposed to the sun or to quartz mercury or the carbon arc lamp—the change being much more rapid with the lamp than with the sun.

After dropping in transmission to about 2 or 3 per cent at 280 $m\mu$, 15 to 20 per cent at 300 $m\mu$, and 30 to 45 per cent at 310 $m\mu$, a further, prolonged exposure to the sun or to the mercury arc has but little effect on the transmission.

After this solarization has taken place the transmissions of the best glasses as just given are rather close to the minimum limit permissible, in order to insure active calcium metabolism, to prevent rickets, etc.

For example in the biological tests, described in *J. Amer. Med. Assocn.* 88, p. 1567, 1927, the sample of Vitaglass used had a transmission (presumably observed when new) of 5 per cent at 280 $m\mu$ and 30 per cent at 300 $m\mu$. The tests were made in January and February and while this sample transmitted a sufficient amount of the ultraviolet, antirachitic rays to prevent an appreciable amount of rickets, it is to be noted that the prevention was not 100 per cent, whereas the prevention was 100 per cent when the exposure was made to the ultraviolet radiation from an arc lamp.

From this it seems evident that a thorough biological investigation is needed in order to establish a minimum limit in spectral transmission at 290 to 310 $m\mu$, that is permissible in order to insure effective results in ultraviolet light therapy.

The ultraviolet transmitting glass of the future may not be so transparent as is some of the best material now available when new, but it should not decrease in transparency on exposure to ultraviolet (especially solar) radiation. The situation may seem discouraging, but there are good reasons for believing that these new facts regarding solarization will bring the question to a climax and that in the near future a glass that is stable to ultraviolet light will be available.

However, the whole situation raises the question, at least in my own mind, whether or not the great publicity regarding the importance of ultraviolet transmitting glasses in our daily lives is not being overestimated. All this publicity is built upon the single fact that window glass shuts out some of the short wave-length ultraviolet solar rays that have the power to prevent rickets. But with so little sunshine in winter, when it is most needed, and with other, simple and equally potent means (arc lamps, and activated oils which are easily administered and easily standardized for dosage) for counteracting this disease, the whole subject seems to be overdrawn.

The unfortunate thing about this publicity is the possibility of raising great hopes in the minds of those who can least afford the price. We have bathing pools in our gymnasiums and it is to be hoped that the time will come when (municipal) light baths from artificial sources will be available, instead of trying to gain an uncertain amount of ultraviolet solar radiation through windows, especially in private houses and offices where only a small part of the building consists of windows. As already stated, for solariums and especially-built sun-parlors, in hospitals, where the nude, or partially nude body can be exposed to solar radiation, these new glasses will be of great benefit.

The problem is essentially biological. But the architect, the engineer and the physicist are also vitally interested—the latter because he is called upon to assist in devising means for standardization of the dosage and determining the spectral composition of the radiation stimulus. The questions raised and the suggestions offered in this paper are the results of an attempt to assist in solving some of the problems presented; and in no wise is it an attempt to encroach upon the domain of the physician in the application of radiation for therapeutic purposes.

Potash Found in Nova Scotia

Potash deposits have been discovered in Nova Scotia, according to the U. S. Consul at Halifax. A Swedish geologist, who for some time has been investigating the potash deposits at Malagash, Nova Scotia, has predicted that a discovery of large potash deposits at that place is imminent. It is understood that drilling operations will be undertaken very shortly. The area selected is part of the property of the Malagash Salt Products, Limited, Malagash, Cumberland County.

THE WALSH FIRE CLAY PRODUCTS COMPANY, whose plant is located in St. Louis, Mo., has been combined with the Harbison-Walker Refractories Company, Pittsburgh. The New York office heretofore maintained by the Walsh Company will be continued.

Glass Industry

ESTABLISHED 1920

The First Trade Journal Devoted Primarily to Glass Technology, Engineering, Raw Materials, and Glass Factory Equipment and Operation

Published Monthly

Copyrighted, 1927, by

GLASS INDUSTRY PUBLISHING COMPANY, INC.
50 Church Street, New York

Telephones { Cortlandt 2465 / Cortlandt 5618 — Cable Address, Glasdustry

J. B. KRAK, Technical Editor

Subscription Price.....$2.00 a Year
Single Copy.....20 Cents

THE GLASS INDUSTRY circulates extensively among American and foreign glass manufacturers, their business executives and technical and factory operating staffs.

CONTRIBUTIONS

THE EDITOR welcomes practical articles on all subjects related to GLASS MANUFACTURING. Such articles, if accepted, will be paid for at our usual rates.

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Superpower and the Glass Industry

An event of great importance to the glass industry, as to all industries consuming large amounts of electric power, is the linking together of North and South into a ten million horsepower system, reaching from Pensacola to Boston which is now being completed. The first connection was established through the opening for service of a 132,000 volt transmission line between Kingsport, Tennessee and Saltville, Virginia, on September 6th.

The men responsible for this important advance in electric power transmission declare that this gigantic "power pool" will go far toward giving efficient, uninterrupted service to all parts of the country reached by the system. While it does not include the metropolitan district of New York, it does include other great cities such as Boston, Chicago, Philadelphia, Atlanta and Birmingham, and will very likely also include the large electrical resources of the Detroit district.

The effects of the formation of such power combinations will be a means of checking the tendency of large cities to grow at the expense of the smaller ones. The growth of large industrial centers has in the past been due largely to the fact that power could only be obtained cheaply and abundantly wherever the demand was large in a small area. Interconnection will now make possible a steady, dependable flow of power to small towns and villages, which never could have hoped to supply it themselves.

The territory covered by the newly established power reservoir contains a large number of glass factories, which have been located with special reference to accessibility of fuel. Now that power in many instances has become a factor, second only in importance to fuel, in some branches of the glass industry, the formation of power pools are to be regarded with great satisfaction.

In this connection it may not be out of place to express the hope that the coming government investigation of the great power combinations, such as the Insull, Byllesby, Stone and Webster interests, The North American Company, the Southeastern Power Company, and others, will not put restrictions in the way of their development such as were devised to restrain the trusts during the Roosevelt administration. It is clearly to be seen that the present tendency is to retrace many steps then taken. The power development of this country, which in a large measure is responsible for the tremendous industrial growth of the past ten years, might be seriously retarded by political interference.

A Statement of Policy

It is an important question to be decided by the editors of a journal like THE GLASS INDUSTRY, as to how much should be published with regard to scientific questions, which, although closely related to the glass manufacturing industry, are outside its scope. Such a question has arisen with reference to the publication of research work, and opinions based thereon, on the subject of ultraviolet transmitting glasses.

That this subject at the present time is most vital to the whole flat glass industry cannot be denied by anyone conversant with the situation. A frank discussion therefore of

the editorial policy of this journal with regard to matters of this nature is, in our opinion, both timely and in order.

We have invited manufacturers of ultraviolet transmitting glasses to give us such information as was available for public knowledge, and in practically all instances we have met with a most cordial compliance with this request. However, while the statements made in such articles are published, it should be clearly understood that in doing so we, as editors of this journal, do not accept responsibility for their accuracy. All we guarantee is that they have been made by men of recognized standing in the technical and scientific world, and are accepted as such. We do not claim to be biologists or physicians, and for that reason we cannot fairly be held responsible for printing opinions of men who are.

Elsewhere in this issue is published an abstract of a paper from one who is an authority on radiometry, and whose name is a guarantee of accurate, scientific observation. In this instance, the opinions expressed do not coincide with those coming from men of science, who have testified in no uncertain terms as to the efficacy of ultraviolet transmitting glasses, not only to the afflicted, but also to those who are in good health. We have felt that space should be given to both sides of the question, without involving us in any way.

Personally we are inclined to believe that the truth will be found to lie between the two extremes of optimism and pessimism, both of which have been published in these pages. However that may be, it is felt that in a technical paper we are concerned only with technical information. We enthusiastically support the manufacturer of ultraviolet transmitting glasses, as it is a technical achievement for which there is great need, as we have pointed out long before there was any glass of this kind on the market.

We also feel that it is not within our province to enter upon a discussion of the biological effects of ultraviolet radiations, as this would be encroaching upon the work of the medical and biological journals, something for which we have neither the ability nor the inclination.

Technical Consultation Service

The Nature of Ultraviolet Rays

QUESTION 111.—What are ultraviolet rays, and in what respect do they differ from ordinary light rays?

ANSWER: Sunlight is white, and without coloring. Sir Isaac Newton, in 1666 was the first to recognize the fact that white light is not simple in its composition, but is the result of a mixture of colors. The colors of which white light is composed may be separated by refraction. A succession of colors in the order of their refrangibility, obtained from any source of light, is called a spectrum. The separation is due to the different degrees of deviation which colors undergo by refraction.

Light can be analysed by means of a glass prism. The water drops of a rain, falling while the sun is shining, may under favorable circumstances analyse the light and cause a rainbow.

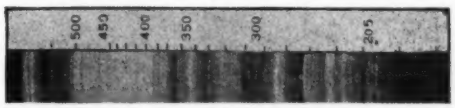
Red, which is always least turned aside from the straight path is the least refrangible color. Then follow orange, yellow, green, blue, and violet, in the order of their refrangibility.

The color of light is determined by vibration-frequency, or, in other words by the corresponding wave-length. The light waves diminish in pitch from the red to the violet. As pitch depends on the frequency with which aërial waves strike the ear, so color depends upon the frequency with which ether-waves strike the eye. The difference between violet and red is a difference analogous to the difference between a high note and a low note in singing.

It appears that the speed of propagation of light waves in a vacuum is the same for all wave lengths. But in a refracting medium, such as a glass prism, the short waves are more retarded than the longer ones, hence they are more refracted. This is the cause of dispersion.

Instead of observing the spectrum by the eye, it may be received on a photographic plate and photographed. When this is done it is found that there are rays beyond the violet light of the visible spectrum and still shorter in wave-length, which act on the photographic plate. However, they are invisible to the eye. These rays are called *ultraviolet* rays.

Study of the spectrum by means of a delicate thermopile or bolometer, by which the heating effect of the rays at each point



of the spectrum may be determined has shown that beyond the red end of the sun spectrum there is an invisible region where the radiation has great energy or heating power. This region is known as the *infra-red*. Its waves are *longer* than those of the visible red, whereas the ultraviolet rays are *shorter* than the violet.

There is no reason to suppose that the infra-red or ultraviolet radiations are different from light waves, except in wave length. For the sake of convenience we speak of heat rays, luminous rays and chemical or actinic rays, as though there were three different kinds of radiation. In the use of these terms care should be taken to guard against such a conception.

The rays visible to the human eye include the wave-lengths of from a little over 700 down to about 390 millionths of a millimeter. Below 390 millionths of a millimeter, we find the ultraviolet rays. The rays that are most effective chemically and physiologically are those shorter than 310 millionth of a millimeter.

In the illustration, wave lengths are indicated in millionth of a millimeter, usually expressed as $m\mu$. The spectrogram shows the open iron arc, a convenient source of ultraviolet rays.

Colored Glass and Decorated Containers

By THEODORE LENCHNER[1]

The present educational program designed to acquaint the public with the advantages of the glass container could have been given an added significance if our container manufacturers had visualized the greater sales possibilities through the use of color. This subject refers not only to colored glass, but to containers made attractive through the use of the so-called "vitrifiable colors," which are fused to the glass. It is the writer's impression that the public, once converted to the principle of "See what you buy in glass" would next give preference to those containers possessing that added touch of appeal known as color.

We have heard much about the use of color in advertising. It has also been agreed by business psychologists and the government that color used in articles of merchandise and in advertising, outpulls black and white in the proportion of about 5 to 1. Indeed, the present tendency is to eliminate the austere all white kitchen in favor of the kitchen whose walls, floors, furniture and utensils are enhanced with a variety of tints and shades. Then, why would not the housewife, who is the principal buyer of food in containers, give preference to those containers which are embellished or decorated with color? It therefore behooves us to give careful consideration to the force of color as a sales stimulant.

The manufacturer will at once point to the colored label on a glass container as the answer. Indeed, this is an answer, but will it suffice? The writer's experience with this temporary form of embellishment or decoration leaves much to be desired. While the colored paper label is necessary in that it describes the contents and gives other printed information, it does not necessarily serve to give the container the exclusiveness which the manufacturer is seeking. Even the design of the container will not give the individuality desired.

A container manufactured from colored glass, or one having

[1]Roessler & Hasslacher Chemical Company, New York.

decorated thereon an indestructible, distinguishable color or colors which can be recognized at a distance or at a glance, would serve best to identify that particular container. Can it be doubted that new life and individuality were put into the fountain pen industry through the use of the bright red barrelled product of Parker? So it is with the glass container industry. If glass is to replace the bright, oft-time gaily colored tin can, the subject of colored glass containers or color decorated containers must be given some thought by the glass manufacturer.

The easiest, simplest, and most economical method of presenting color in glass containers is, of course, through the addition of coloring oxides, to the glass batch. However, this field is rather limited to the few colors which are capable of being produced in the batch and still remain transparent. The limit of one color also will be obvious. A greater field of embellishment is in the use of vitrifiable colors; colors which may be applied to the finished glass container and then refired to a temperature which will fuse these colors to the container and become an integral part thereof. This method presents a pallette of color large enough to supply even the most fastidious. The decoration or color may be but a single line around the container, yet that container will be identified permanently. A number of lines, a simple pattern, a trade mark or solid area of color may serve as a medium of expression through color. The particular problem is to draw attention to the container and *its contents*. Even the precious metals, gold and silver, may be permanently fused to the container, and who will gainsay the fact that gold and silver do create a desire to possess.

The glass container manufacturer may look askance at the cost. However, the cost of colored glass is only very slightly higher. The color decorated glass which involves an extra handling and firing will naturally cost more, depending upon the amount of color decoration involved. To those who believe this added cost might be justified in individuality which the decorated container will possess and the sales appeal of color, let it be added that the cost is probably not prohibitive. Of course, the type of decoration, the amount of color, and the facilities for applying and firing these colors are variable factors. Constantly improving methods of production of color-decorated glass articles has lowered costs considerably, and there is still room for improvement. To gain an idea of cost, one needs only to stroll through the five and ten cent stores and note the decorated glass which is offered at these prices. Keeping in mind the probable manufacturing cost of the glassware before decorating, the cost of decorating with color will at once become obvious.

The additional equipment required is not very great. A decorating lehr whose firebox will maintain a temperature of about 1,000 degrees F. is the largest item of expense. Besides this, a spray gun installment, (if colors are to be applied by spraying), and facilities for grinding the color with a suitable vehicle, constitute the major proportion of equipment needed. The personnel required to apply the color will, of course, vary with the production. However, it may be stated that girls can be trained to do this type of work very efficiently.

Color, in its relation to manufacturing and selling, is more and more being placed on a scientific basis. For instance, the effect of certain colors on appetite, on emotions, on surrounding objects or settings, etc., has been determined by the color expert and the decorator. The proper selection of color for a container in relation to its content had best be left to them, although the manufacturer will have ideas which will contribute to the attractiveness of the container, and the salability of the product.

Recent Patents

NEW INVENTIONS DESIGNED TO IMPROVE GLASS AND THE MEANS OF PRODUCING IT

Complete copies of U. S. Patent Specifications may be obtained from the Commissioner of Patents, Washington D. C. Price 10c each

APPARATUS FOR THE MANUFACTURE OF GLASSWARE. U. S. 1,642,741. Sept. 20, 1927. David L. Middendorf, Columbus, O., assignor to the Federal Glass Co. Filed 10/3/22. In employing a shallow type of mold, when the molten glass is charged into the mold and it is moved rapidly to pressing position, there is not enough time before the mold registers with the pressing mechanism for the glass in the mold to settle or adjust itself to a sufficient level for properly pressing the same to form a fully shaped article. The principal object of the invention is to provide means for settling or adjusting the glass in the mold to a desired height before the pressing mechanism starts to become effective, whereupon the forming of a fully shaped and commercial article is positively insured when the pressing mechanism is actuated.

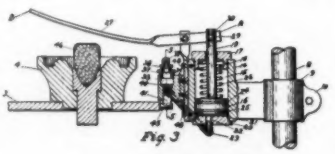


Fig 3

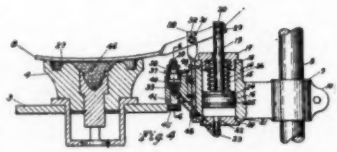
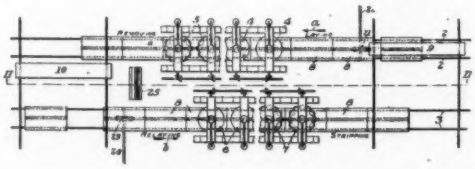


Fig 4

APPARATUS FOR AND METHOD OF ANNEALING GLASSWARE. U. S. 1,642,790. Sept. 20, 1927. Orie Shackleford, Fairmont, W. Va., assignor to Hartford-Empire Co. Filed 4/24/23. The invention is particularly directed to provisions for changing the vertical height of the lehr passage, preferably by adjusting the upper wall of the passage toward and from the bottom so as to maintain a minimum clearance between the top of the ware and the top wall of the lehr. Another object is to provide new and improved means for controlling the temperature of the lehr, by inclining it longitudinally from a horizontal plane and providing means for adjusting the angle of inclination whereby the tendency of the heated atmosphere to rise to the higher end of the lehr may be utilized and regulated. Another object of the invention is to provide a new method of operating a lehr whereby the ware may be annealed by its own heat which it carries into the lehr, without the necessity of reheating the ware between the time that it is formed and the time when annealing is completed.

METHOD AND APPARATUS FOR SURFACING SHEET GLASS. U. S. 1,644,369. Oct. 4, 1927. J. W. Cruikshank, Pittsburgh, Pa. Filed 12/14/23. The method of surfacing sheet glass by the continuous



process wherein a series of table sections are continuously propelled beneath surfacing elements, which consists in first rigidly coupling empty table sections together to prevent relative movement thereof and to form a continuous glass receiving surface composed of a number of tables, then laying glass to be surfaced on this receiving surface irrespective of the location of the glass with reference to the joints between table sections, and then passing the rigidly connected table sections under the surfacing elements.

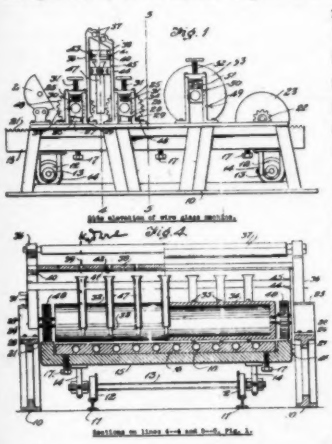
METHODS AND APPARATUS FOR FEEDING MOLTEN GLASS. U. S. 1,645,221. Oct. 11, 1927. William T. Barker, Jr., Hartford, Conn. Assignor to Hartford-Empire Co. Filed 11/20/26. The method of feeding molten glass in mold charges, which comprises discharging a mass of glass through an outlet in a container under the influence of the expulsive movement of an impelling means,

severing a mold charge from such mass, expelling a further mass of glass under the continued expulsive movement of the impelling means, and severing a mold charge from such further mass.

FEEDING MOLTEN GLASS. U. S. 1,644,893. Oct. 11, 1927. Karl E. Peiler, West Hartford, Conn. Assignor to Hartford-Empire Co. Filed 9/1/25. In heating the discharge chamber of a glass feeder having parallel side walls, a curved portion connecting the side walls and a vertical flow-controlling implemcnt forming a heat obstruction in the forward portion of the chamber, the method that comprises projecting a heating flame forward and downwardly along a side wall of said chamber and to one side of the obstruction circulating the flame around the forward portion of the obstruction and the curved walls and causing the flame to return to the rear of the chamber in contact with the glass.

New Wire Glass Machine

An application by Joseph Hastreiter, 491 University Avenue, Morgantown, W. Va., for a patent on a method and apparatus for making wire glass was allowed recently and will be issued shortly. In this method the hot glass is poured on the table and the motor started. The glass is then rolled out into a sheet with upstanding ribs. As it passes beneath the guide tubes the wires rest on these ribs, and as the sheet passes the roll 34 the ribs 35 force these wires into the glass. The roll 53 closes the grooves made by the ribs 35. When the bed has nearly reached the end of its stroke, the wires are cut off and the sheet may be removed in the usual manner.



Different Operation Not Evasive of Patent

A decision handed down recently by the District Court, Western District of Wisconsin, in a suit in equity for infringement of patent, declares that when defendants' method is different in operation from patentee's method, and the differences follow the teaching of a later patent, and are not evasive of the patentee's operation, there is no infringement.

Decision in Coca-Cola Bottle Case

In an action brought by the Coca-Cola Company against the Whistle Company of America for infringement of the firm's design patent No. 48,160, a decision has been rendered by Judge Morris in the District Court of Delaware declaring that no infringement exists. The decision states that the general characteristics of the design are not such that confusion would be caused and that the most casual observer would find no difficulty in distinguishing one bottle from the other. The Judge also declared that there is only contrast and not similarity between the ornamentation of the two bottles, and that the same is true of the proportions or symmetry of the respective bottles.

Plaintiff Wins Suit for Royalties

In the case of Charles H. Blue of Charlottesville, Va., who sued the Hazel-Atlas Glass Company for royalties on the use of certain glass making machinery, Judge J. B. Summerville in the Circuit Court, Ohio County, West Virginia, handed down a decree on October 10 awarding $300,000 in royalties to the plaintiff. Mr. Blue claimed that his invention was turned over to the Hazel-Atlas Company and was used by them from 1905 to 1921, when the suit was instituted in the circuit court. The defendants claimed that the machine turned over to them by Mr. Blue was unsuitable and that numerous attachments and improvements had to be made, making the machine virtually a new one, different from that patented by the plaintiff. The Court fixed the minimum royalties at the rate of $20,000 per year, a total of $300,000 for the 15 years, dating from the time the original agreement regarding royalties was made up to the time the suit was filed. A stay of 90 days was granted to the defendant pending an appeal to the higher court.

Feldspar and Feldspar Production in North Carolina

By Jasper L. Stuckey[1]

North Carolina for several years has been the leading producer of minerals commonly found in pegmatite dikes, these dikes being essentially coarsely crystalline granites occurring in bodies and lenses of varying size which have been intruded into older crystalline rocks in a liquid state. These pegmatite dikes contain feldspar, quartz, white mica (muscovite), black mica (biotite) and other minerals, such as beryl, garnet and tourmaline. The chief minerals mined from these dikes in North Carolina are feldspar (and its weathering product, kaolin), mica and some quartz.

Feldspar was first mined in Mitchell county in 1911. That year only one producer reported. By 1917 North Carolina had become the leading producer of feldspar, which record it still holds. The annual production now amounts to around 40 per cent of the total yearly production of the United States.

No other industry in North Carolina has changed and improved its methods so much in the past 10 years as feldspar mining. In 1911, when the mining of feldspar was first started, there were no local markets for its sale and the crude mineral had to be shipped some distance to a market. This condition made it impossible for an individual without capital to go into the mining of feldspar. The Carolina Mineral Company, which now operates as a part of Golding Sons Company, was the first actually to mine and ship feldspar.

Lack of sufficient knowledge as to the quality of feldspar in different deposits, as well as a lack of knowledge of the size, occurrence and best methods of mining the deposits, left the production largely to the small producer. These conditions apparently existed in other States as well as North Carolina, until the close of the war in Europe. According to R. E. Ladoo, mineral technologist, United States Bureau of Mines, Reports of Investigations, Serial No. 2311, "Conditions in the Feldspar Industry," January, 1922, conditions got so bad in the industry about 1920 that the bureau was called upon for help. Ladoo's report doubtless went a long way toward improving the situation.

In North Carolina the need for a more uniform product at lower mining cost soon became very evident. The result has been that in the past four or five years there has been marked reorganization of the industry. Miners became grinders, and grinders became miners. Small dikes and small deposits were abandoned and larger deposits, on which systematic mining could be done, were sought.

This reorganization of the feldspar-producing industry was culminated in 1926, when Golding Sons Company brought together under one head the Carolina Mineral Company, the Erwin Feldspar Company and the Clinchfield Products Corporation, its first purchase, about 1924, being the mill established by Carl Willms, Jr., of Baltimore. Prior to this time the North State Feldspar Corporation had taken over several individually owned mines near Micaville. The Tennessee Mineral Products Company is also operating six mines near Spruce Pine and Penland which were formerly owned and worked as separate properties.

When feldspar mining first began in North Carolina the mineral was shipped crude to grinding mills at points in West Virginia, Ohio, New Jersey, etc. A. S. Watts, in 1912, called attention in a bulletin of the United States Bureau of Mines, "Mining and Treatment of Feldspar and Kaolin," to the possibility of grinding the feldspar at a better profit. Soon after this a mill was built at Erwin, Tenn. This was followed in a few years by three other mills in Tennessee, two at Erwin and one at Bristol, all con-

[1] Department of Geology, North Carolina State College of Agriculture and Engineering. Abstracted from *Manufacturers Record*, Baltimore, Md., issue of June 30, 1927.

veniently located to the North Carolina feldspar district around Spruce Pine. In 1923-1924 the North State Feldspar Corporation built a modern mill at Micaville, Yancey county. The Tennessee Mineral Products Company of Bristol completed in 1926 a modern mill at Spruce Pine. The first mill at Erwin was built, and for a time was owned, by the Clinchfield Products Corporation, which now has become a part of the Golding Sons enterprises. The two other mills were owned by Golding Sons Company and the Erwin Feldspar Company, which consolidated last year and still own those properties. The Bristol mill is owned and operated by the Tennessee Mineral Products Company.

Improvements in milling have been just as great and as important as those in mining. Today every mill closely situated to and depending on the North Carolina fields for its spar, is modern throughout.

NARROW VEIN IN ENGLISH KNOB MINES, ERWIN FELDSPAR CORPORATION

That North Carolina feldspar meets the approval of the ceramic trade is shown by the fact that the production jumped from 35,000 tons in 1920 to 97,000 tons in 1924. Estimates in the Engineering and Mining Journal for the year 1926 are about 85,000 tons. This has been brought about by the development of larger deposits and the production of a very uniform product.

The following analyses indicate the quality of feldspar being mined. An average analysis[2] of 165 carloads of 50,000 pounds each from a group of Golding Sons Company's mines shows SiO_2, 68 per cent; K_2O, 10.10 per cent; NA_2O, 3.00 per cent; Al_2O_3, 18 per cent. The Crabtree Falls mines average about as follows: SiO_2, 67.82 per cent; Al_2O_3, 19.40 per cent; Fe_2O_3, 00.05 per cent; CaO, trace; MgO, trace; K_2O, 10.14 per cent; Na_2O, 2.52 per cent. A typical analysis of the feldspar from the Deer Park mine No. 5 is as follows: SiO_2, 67 per cent; Al_2O_3, 18 per cent; K_2O, 12 per cent; Na_2O, 2.50 per cent. A typical analysis of No. 1 feldspar being produced by the North State Feldspar Corporation is as follows: SiO_2, 65.92 per cent; Al_2O_3, 18.89 per cent; Fe_2O_3, 00.03 per cent; CaO, 0.11 per cent; MgO, trace; K_2O, 12.80 per cent; Na_2O, 2.24 per cent. An average Maine feldspar, according to Charles M. Franzheim, has about the following composition: SiO_2, 69.30 per cent; Al_2O_3, 16.17 per cent; Fe_2O_3, 0.07 per cent; CaO, 0.12 per cent; K_2O, 9.00 per cent; Na_2O, 3.04 per cent; loss on ignition, 1.39 per cent.

[2] Furnished by S. T. Henry, Spruce Pine, N. C., president of the Tri-County Association.

These analyses indicate a North Carolina feldspar that is probably equal to any in the country. The most important factor, however, is a uniform product. Such a product is now being turned out by every mine and mill in the State.

The main feldspar-producing area in North Carolina is the Spruce Pine district.

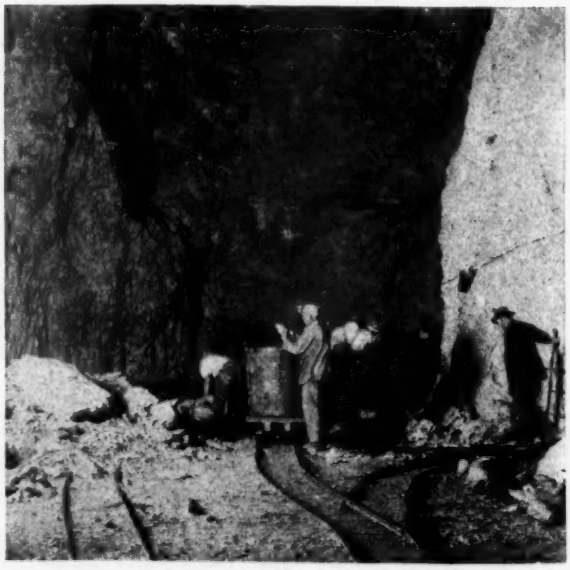
The North State Feldspar Corporation, located at Micaville on the Black Mountain Railroad, owns several hundred acres of valuable mineral land on which three mines are being operated.

The Goog Rock Mine, which is one of the important mines owned by this company, is located on the east side of South Toe River, one and one-half miles north of Micaville and just across the river from the Black Mountain Railroad.

The Tennessee Mineral Products Company, with its present mill and holdings at Spruce Pine, is also the outgrowth of several years of careful study. Some five or six years ago Frank P. Knight, of Beverly Hills, Boston, became interested in North Carolina feldspar, organized the Tennessee Mineral Products Company and built a feldspar grinding mill at Bristol. Also, he secured control of some promising properties at Spruce Pine and later placed an experienced mining engineer in charge of the mining operations. For five years careful studies were made of every angle in the feldspar-producing business, with the result that this company has just completed at Spruce Pine one of the best designed and most up-to-date feldspar mills in the country. The company also controls some 2,000 acres of choice mineral land on which six feldspar mines of importance are being operated.

The Deer Park mine No. 5, owned by this company, is one of the largest in the State.

The feldspar property of Golding Sons Company in North Carolina represents, in its present stage of development, the work of several smaller companies over a number of years. The combined holdings in North Carolina today amount to several thousand acres of land, on which several important mines are being operated. At Erwin, Tenn., this company owns three mills, where a large part of the feldspar from its mines in North Carolina is ground.



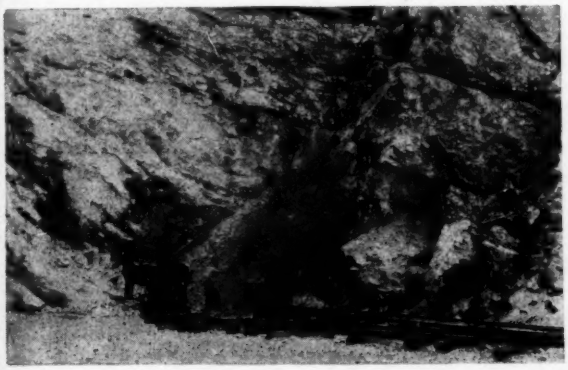
UNDERGROUND MINING AT DEER PARK MINE, TENNESSEE MINERAL PRODUCTS COMPANY

Golding Sons Company first took over the Carolina Mineral Company of Penland and began operating, among others, the Hoot Owl mine, about five and one-half miles south of Penland and served by a narrow-gauge railroad. Feldspar is being mined by the open cut, or quarry, method from a giant pegmatite of unknown size. This mine has been a big producer of high-grade feldspar.

The Clinchfield Products Corporation division of Golding Sons Company was the first company to build a mill at Erwin, and this mill was the first one built convenient to the North Carolina deposits. This mill was built in 1914, and since that date the Clinch-

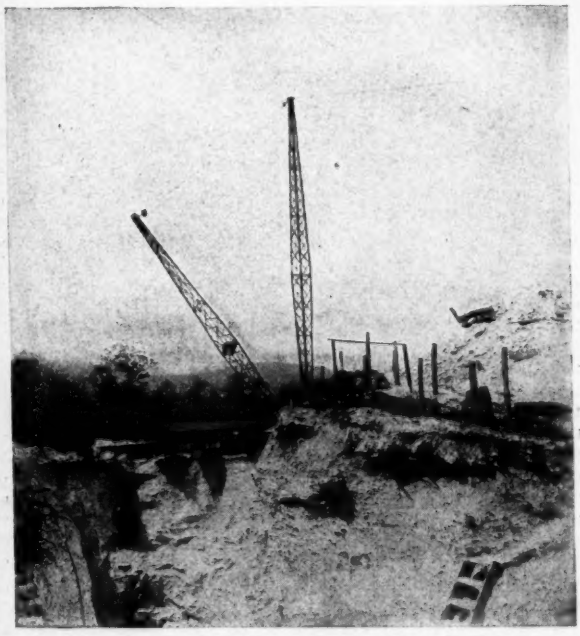
field Products Corporation has done much toward developing North Carolina feldspar. Among the different feldspar deposits prospected by this company, the Hawkins mine, two miles northwest of Spruce Pine, is of interest, because it has been an important producer of feldspar and also because it was here that the first washing screen and picking belt were installed.

The Erwin Feldspar Company, which is one of the largest units in the greater Golding Sons Company, had by consolidating with the Crabtree Feldspar Company in 1924 built up a large business and secured control of several hundred acres of valuable feldspar land. Two of the most important mining properties of this com-



HOOT OWL MINE, CAROLINA MINERAL COMPANY, PENLAND

pany are the Crabtree Falls mines and the English Knob mines. The Crabtree Falls mines are located on Crabtree Creek, about six miles southwest of Spruce Pine and eight miles south of the Clinchfield Railroad at Boonford. The feldspar is carried from the mines to the railroad over eight miles of narrow-gauge railroad. On this property, which consists of approximately 2,000



OPEN CUT, HAWKINS MINE, CLINCHFIELD PRODUCTS CORPORATION.

acres, are two main dikes of feldspar, on which are found a number of promising outcrops. Mines No. 20 and No. 29 were producing most of the feldspar shipped from this property in 1926, which during the summer average around 2,000 tons per month. Mine No. 20 is the largest on the property and doubtless contains a large amount of high-grade potash feldspar. It has not been fully developed, but the present opening shows a total length of approximately 400 feet, a width of 40 to 75 feet and a depth of 120 feet. These dimensions represent the body of spar as it is being worked, and not the width and length of the dike. At the present rate of production, this property contains feldspar sufficient for many years of mining.

The English Knob mines are located about two and one-half miles northeast of Spruce Pine. The feldspar is brought about two miles by narrow-gauge railroad, dumped into storage bins and then relayed to the railroad at Spruce Pine by wagon and truck.

The North Carolina feldspar industry has had a remarkable growth and is today on the best basis in its history. The 1916 production amounted to 31,000 tons, which sold for about $2.20 per ton; the 1920 production amounted to 35,000 tons, which sold for about $5.20 per ton; the 1924 production amounted to 97,000 tons, which sold for about $6.80 per ton, while the best estimates for 1926 are around 85,000 tons, which was about 38 per cent of the total production in the United States. Current market quotations for crude spar from North Carolina at the present time range from $6.50 to $7.50 per ton.

This does not mean, however, that the industry is free from

ENTRANCE TO GOOG ROCK MINE, NORTH STATE FELDSPAR CORPORATION

problems and difficulties. Competition in the industry throughout the country is keen and North Carolina feldspar is still selling slightly below the New England market quotations. The industry in North Carolina has doubtless reached its present importance largely because it has been able to produce large tonnages at comparatively reasonable costs. This condition is rapidly disappearing, and larger productions have called for bigger developments and bigger outlays of capital. Mounting costs are being carefully watched.

The best estimates indicate sales of 225,000 tons of ground feldspar in 1926. About 85,000 tons of the crude spar for these sales were mined in North Carolina. A total of 35 mills had a part in the grinding of the year's total output. If each of these mills had run 300 days during the year and produced 50 tons of ground spar each day, the total output would have been 525,000 tons. This means that the market was necessarily a buyer's market and not a miner's or grinder's. But, in the face of these conditions, many of the users of feldspar were willing to pay a premium for a high-grade, uniform product.

The use of feldspar in the ceramic industry is doubtlessly just in its infancy and what its future is to be no one can say.

Anyone interested in, or planning to enter, the industry should study carefully the market demands, as well as possible deposits. No mining operation should be undertaken without the help and advice of a trained geologist or mining engineer.

The Glass World and What It Is Doing

News of the Industry

Official Costs Investigator Assigned to Belgium

The United States Tariff Commission on October 6 announced the assignment of A. L. Morgan, accountant, to the Commission's office at Brussels, Beglium, in connection with the study of production costs of Belgian window glass which is being made by the Commission. A study of the costs of domestic window glass has been completed under the direction of J. Mark Albertson and covers 95 per cent of the possible production of twenty-six American plants. Mr. Albertson expects to remain in Washington to work on a report covering the recent investigation of production costs of imported plate glass which, after approval by the Advisory Board, will be submitted and voted upon by the full commission, whose findings will eventually be put before President Coolidge.

A new factor may enter into the situation, however, regarding the ascertainment of foreign costs. In an oponion given at the request of President Coolidge and relating to a different investigation Attorney General John G. Sargent on October 21 ruled that the United States Tariff Commission is not required by law to send American agents abroad for its information on costs of production in competing foreign countries. The ruling is general in its nature, and does not attempt to say in what manner the Tariff Commission shall obtain its information of production costs in connection with its investigations under the so-called flexible provision, of the Fordney-McCumber Tariff Act.

Whether the method of basing estimates of foreign costs on invoice figures will be applicable to glass imports remains to be seen.

The United States Tariff Commission's activities in obtaining cost data from the foreign manufacturers was referred to recently by Edgar B. Brossard, a member. According to the *United States Daily*, Mr. Brossard on October 19 said that foreign producers had become assured that the information given to the Commission would be kept confidential and not permitted to get into the hands of their competitors in this country.

Mr. Brossard said: "There is apparently no opposition to the work in Germany.

"In Belgium the plate glass manufacturers first declined to give information on their costs of production in Belgium. But after two of their manufacturers had appeared before the Tariff Commission at the public hearing and saw how the work was conducted they evidently became convinced that the Commission's investigations were conducted in a scientific, impartial, and thorough manner and offered to furnish the Commission with cost data from their books if the Commission would send its agents to Belgium again. This the Commission did, and obtained the costs of production in that industry from all the Belgian producers.

"Since that experience the Commission has had no difficulty in getting data from Belgian producers. This last summer data were obtained without opposition in Belgium from the Belgian producers of whiting, and permission was obtained to obtain the data on costs of production from the Belgian window glass manufacturers."

Sweden and Italy in 1925 and the following year raised objections to the Commission's investigation of certain products, but after Chairman Marvin had explained the Commission's purpose and methods, access was given to their cost records.

Chemical Industries Exposition

The Eleventh Annual Exposition of the Chemical Industries, held at the Grand Central Palace, September 26 to October 1, included as usual displays of interest to the chemical industries, including glass manufacturing. A number of manufacturers who cater more or less to the glass industry had exhibits. Among them were Barnstead Still & Sterilizer Company, Boston, Mass., manufacturers of water stills; The Bristol Company, Waterbury, Conn.; Brown Instrument Company, Philadelphia; Leeds & Northrup Company, Philadelphia; Chas. Engelhard, Newark, N. J.; Pyrometer Instrument Company, New York, all manufacturers of pyrometers; The Carborundum Company, Perth Amboy, N. J., grinding wheels, etc.; Celite Products Company, Los Angeles, Cal., Sil-O-Cel insulating brick; Eisler Engineering Company, Inc., Newark, N. J., special glass glass making machinery; Foote Bros, Gear & Machine Company, Chicago, Ill., General Electric Company, Schenectady, N. Y., motors and air compressors, etc.; Henry A. Golwynne, New York, mullite for refractories; Mathieson Alkali Works, Inc., New York, soda ash, etc.; United Chromium, Inc., New York, chromium electroplating for glass rolls and molds; Wellman-Seaver-Morgan Company, Cleveland, O., gas producers; Williams Patent Crusher & Pulverizer Company, St. Louis, Mo., cullet crushers, etc.; Dings Magnetic Separator Co., Milwaukee, Wis.; Quigley Furnace Specialties Co., New York, insulating brick. Glass manufacturers included: American Optical Company, Bausch & Lomb Optical Company, Corning Glass Works, Eimer & Amend, Hanovia Chemical & Manufacturing Company, Vitaglass Corporation.

A large booth maintained by the Corning Glass Works was one of the centers of attraction. It showed examples of Pyrex products for laboratory, household and other purposes, ultra-violet flat glass, and other specialties. Frederick Kraissl, Jr., 17 Madison Avenue, New York, gave demonstrations of glass blowing with Pyrex every hour.

Organizing a Ceramic Council

A meeting of ceramic manufacturers and others interested was held at Columbus, O., on September 21 and 22 to take steps towards organizing a National Council of Ceramic Industries. The meeting had been called by B. Mifflin Hood, president of the American Ceramic Society. It was attended by Ross C. Purdy, secretary of the American Ceramic Society; Hugh Brady, West Virginia district manager for Hazel-Atlas Glass Company; F. C. Flint, of the Hazel-Atlas Glass Company; a number of manufacturers of brick and terra cotta; Prof. George A. Bole, Ohio State University; Stewart Phelps, of Mellon Institute; Prof. C. W. Parmelee, University of Illinois; Dr. A. V. Henry, Georgia Institute of Technology; Prof. A. S. Watts, Ohio State University; Prof. Edward Orton, Jr., and H. B. Henderson of the Standard Pyrometric Cone Company.

The purpose of the council, as set forth in the October issue of the *Journal of the American Ceramic Society*, would be (1) to provide means for correlation and initiation by ceramic manufacturers of America in research, standards, and data; (2) to provide a personnel for collaborating with universities in investigations of problems in fundamental and applied science and in engineering relating to the development, production and use of ceramic products; (3) to take leadership in advisory relations with federal bureaus, state organizations, and trade associations; (4) to promote industrial fellowship; and (5) to provide a central place for the clearing of fundamental and applied information on art, science, technology and engineering, and for listing available means of obtaining such information. The council will be an organization of ceramic manufacturers and equipment and supply companies and will be affiliated with the American Ceramic Society. After considerable discussion, a committee on constitution was appointed, including: Prof. Parmelee, F. C. Flint, George Simcoe, Stewart Phelps, and ex-officio, Ross C. Purdy and B. Mifflin Hood. It was decided to call a meeting of representative trade associations to be held November 17 and 18 at Columbus, when a definite proposition will be presented to those attending.

During the meeting several of those present expressed themselves as being very favorable to the plans discussed and offered to contribute money to assist in carrying them through.

American Window Glass Annual Report

The American Window Glass Company's report for the year ended August 26, 1927, shows a net loss, after all charges, of $381,350 compared with a net profit for the year of 1926 of $420,710. This resulted in a reduction of the surplus on

August 27, 1927 to $10,184,437. Assets comprise: cash, notes and accounts receivable, less reserve for doubtful accounts, $1,761,913; finished products, materials and supplies, $4,585,481; deferred charges, $138,770; plants, real estate and goodwill, less reserve for depreciation, $22,411,548; investments, $19,143 and treasury stock, $5,000; totaling, $28,921,856. Liabilities included: accounts payable for materials, wages, etc., $291,086; preferred stock dividend payable Sept. 1, 1927, $140,000; royalty payable $335,409, reserve for taxes, $970,922, preferred capital stock, $4,000,000; common capital stock, $13,000,000; profit and loss surplus, $10,184,437, making the total liabilities, $28,921,856.

In his report to stockholders, President W. L. Monro said: "Our sales of window glass during the past year decreased from those of the preceding year not only in the number of boxes sold, but in the amount per box received for it. This was due in part to the lessened consumption, and to the large increase in amount imported. The increased imports made necessary the lowering of our selling prices in the seaboard zones in order to compete with the foreign glass. In addition, the competition of domestic glass of poorer quality remote from the seaboard, also forced us to name lower prices in the interior."

Big Glass Container Drive at Pittsburgh

Manufacturers of glass containers of all kinds and their executives, members of The Glass Container Association which includes producers of close to 100 per cent of all machine-made containers in the country are gathering at Pittsburgh as we go to press, for their regular quarterly meeting and to take part in the great drive now under way in that city under the direction of the Association to increase the consumption of glass-packed goods.

During the campaign practically all Pittsburgh dealers in food products are making special displays and sales of goods packed in glass. Meetings of local grocers and druggists associations have been held and much enthusiasm aroused. The movement has had the active support of the big packing interests.

For the members' meetings on October 27 and 28 some interesting addresses were promised, including one by Dr. Herbert D. Pease, head of the Pease Laboratory, on the subject of "Research in Industry." J. P. Thomy, president of Best-Clymer Company, one of the largest preservers in the country, was scheduled for an address on "How Glass Men and Preservers Can Co-operate." On the program also was a paper on "Annealing of Glass," by E. O. Hiller of Hartford-Empire Company; one on "Fuel." by Dr. Thomas S. Baker, president of Carnegie Institute of Technology; "Standardized Depreciation Rates," by John Alden Grimes, Bureau of Internal Revenue; "An Appraisal of the Glass Container Industry as of August 31, 1927," by Fred J. Rummel; "Association Activities," by J. P. Brunt, president of Paperboard Industries Association, and a statement of "Publicity Situation" by I. R. Stewart, chairman of the Publicity Committee, and a Presentation of Publicity Plans by R. V. Bromfield.

A banquet on October 27 at the Fort Pitt Hotel was on the program and a committee consisting of W. G. Gundelfinger of the Diamond Alkali Company, assisted by G. S. Cooper of the same company and R. E. Powell and J. E. Sharp of the Aluminum Company of America was slated to make things pleasant for the golfing contingent. The meeting was held so late in the month that actual happenings there occurred too late to report in this issue.

Opposes Increase in Fluorspar Tariff

The Hazel-Atlas Glass Company, Wheeling, W. Va., on October 10 filed a brief with the Tariff Commission at Washington in connection with the pending investigation into the cost of foreign and domestic production of fluorspar. The brief opposes any increase in the tariff on this material. The Bethlehem Steel Corporation on the same day filed a brief concerning the tariff on fluorspar as affecting the steel industry.

The Hazel-Atlas Company summed up its arguments as follows:

"Any increase in the tariff on the raw materials of this glass would make the selling price necessarily such that we could not cope with the imported competition on these articles. This would mean that our sales would be definitely less and our purchases of the raw materials materially reduced. A very small difference in price on this type of articles will lose our market for us, particularly at this time of very definite and wide decline in prices.

"We do not profess to know anything about the cost in the fluorspar market, but we do feel that an increase in price, which would be inevitable as a result of the protection offered by the increased tariff, would cause us to have to increase our selling prices just at a time when the general market is very much declining, and it is becoming increasingly hard to maintain sales prices as they are. This would put us to a further disadvantage in disposing of this product of our manufacture."

The United States Smelting, Refining and Mining Company filed briefs in favor of a reduction in the rates on acid spar.

Forty-four glass manufacturing companies consumed in the year 1926, 7,973 short tons of fluorspar and had on hand December 31, 1926, a total of 1,342 short tons.

Bureau of Standards Wants Glassblower

The United States Civil Service Commission announces a competitive examination for the position of senior glassblower. Applications must be on file with the Civil Service Commission at Washington, D. C., not later than November 15.

The examination is to fill a vacancy in the Bureau of Standards, Department of Commerce, Washington, D. C., and vacancies occurring in positions requiring similar qualifications.

The entrance salary is $1,860 a year. A probationary period of six months is required; advancement after that depends upon individual efficiency, increased usefulness, and the occurrence of vacancies in higher positions.

The duties consist principally of blast lamp hand work without the aid of molds, and include scientific glassblowing and mechanical assistance in the laboratory where high vacua are used; construction without detail drawings of vacuum tubes of quartz glass and pyrex, and doing the metal work required as well as the glass work.

Competitors will not be required to report for examination at any place, but will be rated on their education, training, and experience.

Estimate Car Requirements for Container Shipments

The report of the glass container committee, J. C. Magness, chairman, of the Atlantic States Shippers Advisory Board on the prospective situation for the fourth quarter is as follows: The car requirements will be about 2,550 cars, which is about 5 per cent more than for the fourth quarter of 1926 and about 20 per cent less than for the third quarter of 1927. The explanation of the drop from the volume of business done in the third quarter of this year is the seasonal lack of activity in certain lines of packing and consumption. Mr. Magness reported that no complaints concerning the transportation service had been received.

The chemical committee, John I. Tierney, chairman, reported that an analysis of replies received from members of the committee to a questionnaire requesting a forecast of business for the current quarter indicates a fair volume of business with little change from the record of the corresponding quarter of 1926.

Immense Potash Deposits Found in Russia

Prof. D. M. Mushketov, director of the Soviet Geological Survey and other geological organizations, in a statement recently issued at the office of the Amtorg Trading Corporation, New York, declared that recent discoveries of immense potash beds in the Solikamsk and Berezniaka regions of the province of Perm in the Soviet Union have increased the potash resources of the world by two-thirds.

Appropriations of the Soviet Government for geological work in 1927 amount to over $4,000,000, as compared with $100,000 appropriated by the Russian Government in 1913.

Mirror Manufacturers Hold Election

At a meeting held in Chicago on September 22, the Mirror Manufacturers Association elected the following officers: George H. Anderson, president; Fred Hagemann, vice-president and Enos Porter, treasurer. Harry C. Sorden was re-elected secretary. Members of the executive committee are: Robert Schrenk, New York; Paul Kinsella, Chicago; C. F. Emerson, Jamestown, N. Y.; B. P. Donnelly, Holland, Mich.; Fred Slane, High Point, N. C.; M. Murnane, St. Louis.

The next meeting will be held in Pittsburg, December 6-7.

Changes in Organization of Bureau of Standards

The Department of Commerce recently announced through Dr. George K. Burgess, director of the Bureau of Standards that changes in Bureau have been made which divides its activities into two new divisions; one, under Dr. L. J. Briggs, chief scientist in charge of the Division of Mechanics and Sounds, will be devoted to research and testing and the other, in charge of Ray M. Hudson, chief of the Division of Simplified Practice, will be devoted to industrial and commercial activities.

Our Foreign Trade in Glass and Glassware

Imports of glass and glass products for the month of August, 1927 decreased from the corresponding month by the amount of $241,427, the total value being $1,526,948. Exports also decreased to the amount of $17,955, the total value being $693,138. Complete details by products and also figures for the eight months ending August, 1927, are given on page 278, this issue.

Confirms News of New Process at Rossford

The fact that the Edward Ford Plate Glass Company, Rossford, O., is installing the Bicheroux process of manufacturing plate glass, as stated in our October issue, has been confirmed by George R. Ford, president of the company, through Vice-President C. J. Husted.

Plate Glass Prices Reduced

The Pittsburgh Plate Glass Company on October 15 announced a reduction in selling prices in certain of their plate glass products, principally the larger sizes. Other companies are doing likewise.

Trade Activities

The Cristalerias Rigolleau manufacturers of bottles, have changed their address from B. Mitre, 544 to Paseo Colon, 800 Esq., Independencia, Buenos Aires, Argentina.

The Interstate Window Glass Company's factory at Kane, Pa., resumed operations early in October after a short shutdown for setting blocks.

D. O. Cunningham Glass Company, Pittsburgh, Pa., has repaired both of its tanks and put them into operation. The company looks forward to another successful year.

The Brown Instrument Company, Philadelphia, Pa., announces the recent opening of a branch at 509 Mutual Building, Kansas City, Mo., in charge of F. M. Poole, district manager.

The First Bohemian Glass Works, of Bleistadt, Czecho-Slovakia, according to cable advices to their New York representatives are operating at capacity with orders on hand sufficient to maintain this rate of output for the next two months.

The Adamston Flat Glass Company, Clarksburg, W. Va., have made preparations to have their new tank in operation about the first of October. The tank serves six Fourcault type machines.

The American Plate Glass Company, Durant City, Pa., according to a report in the Warren, Pa., *Mirror,* posted notices on October 18, to the effect that a reduction of 15 per cent in wages would go into force immediately.

The Laurens Glass Company, Laurens, S. C., recently put into successful operation a tank rebuilt and enlarged by the Simplex Engineering Company. They are having also a splendid run on their green tank.

Semon Bache & Company, New York, have obtained a court ruling fixing the duty on gauge glasses for steam boilers at 55 per cent ad valorem, under the fourth clause of paragraph 218 of the Act of 1922, instead of 65 per cent under the first clause of that paragraph.

The Brockway Machine Bottle Company, Brockway, Pa., are now operating their new Dixon tank with very satisfactory results. A new building which is to house three Amsler-Morton new type lehrs is finished and actual work of installing the lehrs has commenced.

National Airoil Burner Company, Inc., announces that its offices and salesroom are now located at 1327 Girard Avenue, Philadelphia, Pa. The company's factory, however, remains at Ninth and Thompson Streets, where it has been located since 1919.

The Thatcher Manufacturing Company's plant at Parmaco, which was shut down about a year ago according to a report from Parkersburg, W. Va., will, if new plans are successfully completed, be re-opened as a beverage bottling factory. Parkersburg business men are said to be interested.

The General Flat Glass Company's newly remodeled plant at Mannington, W. Va., equipped with sheet glass drawing machines of the Fourcault type, was put into operation on October 10, with satisfactory results. Several additional machines will soon be started.

The Western Glass and Pottery Association at a directors' meeting in Pittsburgh, Pa., the nomination of John H. Harris of the Kaufmann department stores to succeed A. Binswanger as president was made. The annual exhibition of glassware and china will be held at various hotels in Pittsburgh beginning January 9, 1928, and will continue for two weeks.

General Electric Company sales billed for the first nine months of 1927, announced October 18 by President Gerard Swope, amounted to $225,959,610.89 compared with $229,638,-216.24 for the corresponding period last year. Profit available for dividends on common stock for the nine months of 1927 was $33,262,241.20 compared with $30,051,619.77 for the same nine months of 1926.

United Chromium Incorporated, is the title of a new corporation formed for the purpose of developing the art of chromium electroplating and its practical applications. Many of the patent rights owned or controlled by the new concern are those heretofore owned and controlled by the Chromium Corporation of America, New York, Electro Metallurgical Company, Niagara Falls, N. Y., and the General Chromium Corporation.

The Michigan Alkali Company, 21 East 40th Street, New York, has issued a general price list for 1928 covering caustic soda, light 58%, and dense 58% soda ash. The price quoted for the dense material is in bulk, $1.22½ per 100 pounds; in bags, $1.37½ per 100 pounds and in barrels, $1.55 per 100 pounds. Spot cars of soda ash 2½ cents per 100 pounds higher. All prices are for shipment in carload lots, F. O. B. works, Wyandotte, Mich., with usual freight equalization.

Graham Glass Company, Evansville, Ind., some weeks ago obtained permits for the construction of a new steel and concrete factory unit to take the place of the wooden structure now used and construction has been started. According to J. M. Lents, president, the new unit will house the storage plant and all machines necessary in the making of bottles. When the building is completed, new machinery will be installed in the factory making greater production possible.

The American Window Glass Company's plant at Belle Vernon, Pa., which was reconstructed during the past summer at a cost of about half a million dollars, including Fourcault sheet drawing machine equipment, will be put into operation early in 1928. The plant has been idle for about three years. It is reported that no plans have been made for reopening the Monongahela City plant, which employs the cylinder process and which has also been idle for several years.

The Celite Company, a Delaware corporation, which controls The Celite Products Company of Maine, Celite Products, Limited, of Canada and Celite Products Corporation, a Delaware corporation doing business in England, has announced a new issue of $1,750,000 first mortgage 6 per cent serial gold bonds which will be used to pay off certain 7½ per cent cumulative preferred stocks, also bank loans and for working capital, etc. From the basic material celite, the Company manufactures heat insulation products, including Sil-O-Cel, Fraxite and Celcote. Mineral deposits and manufacturing plants of the company are located in California where large deposits of diatomatious silica are owned.

Industrial Publications

Pyrometers of Recording, Indicating and Automatic Controlling Types—Catalog L., Wilson-Maeulen Company, 385 Concord Avenue, New York. An attractive loose-leaf catalog, 8½ by 11 inches, with embossed flexible imitation leather cover, clearly illustrating and describing the company's line of pyrometers and their special features. Particular attention is given to the automatic electrical cold junction compensator used with Wilson-Maeulen Tapalog, recording, mono-pivot, indicating and automatic controlling pyrometers. Portable indicators, pyrometer switches, pyods, Nork thermocouples, platinum, and platinum-rhodium thermocouples and accessories are described. Automatic temperature control equipment for regulating oil, gas and electric furnaces, and Type A pyrometer controller are featured.

Personals

Walter O. Amsler, well known throughout the industry, has joined the staff of the Hartford-Empire Company, Hartford, Conn. Mr. Amsler started in the glass business in 1904, after having received the D. S. degree from the Cornell University. Later he was instrumental in organizing the Amsler-Morton Company, of which he was president up to 1922. In that connection he gave particular attention to technical matters, improvements relating to fuel economy for melting furnaces, and to the development of the commercial muffle lehr, along which lines he has always specialized.

George Kubler has severed his connection as night manager at the plant of the J. E. Marsden Glass Works, Ambler, Pa., and is now connected with the Liberty Cut Glass Works, Egg Harbor, N. J., as superintendent.

Recent Deaths

Joseph M. Neenan

Joseph M. Neenan, for several years connected with the Libbey-Owens Sheet Glass Company's Charleston, W. Va., plant in a responsible capacity, died at Cleveland, O., on October 16. Mr. Neenan was 47 years of age at the time of his death and during his career served at different times a number of window glass plants. He became prominent and popular throughout the trade. He was deeply interested in labor affairs and in 1909 was elected president of the National Window Glass Workers, an office which he held for many years.

H. J. Crabbe

H. J. Crabbe of Cleveland, O., whose long connection with the Grasselli Chemical Company had brought him into intimate contact with many glass men and who also was well known and highly regarded in various other chemical consuming industries, died suddenly on September 23. His connection with the Grasselli interests extended over a period of 35 years, his activities being devoted principally to the sales department.

Moses I. Binswanger

Moses I. Binswanger, aged 59, vice-president of Binswanger & Company, glass jobbers, Richmond, Va., with branches at various large southern cities, died at his home in Richmond on September 29, following an illness of about two years' duration.

Coming Meetings

The American Bottlers of Carbonated Beverages will hold their annual exposition at New Orleans, La., November 14 to 18.

The Eastern Glass Distributors Association will hold its next meeting in New York City on November 10.

The Sixth Annual Exposition of Power and Engineering will be held at the Grand Central Palace, New York, December 5 to 10.

The American Ceramic Society annual meeting will be held at the Ambassador Hotel, Atlantic City, N. J., February 5 to 11, 1928. European tour of Society will cover the period from May 19 to July 5, 1928, and will include visits to England, Germany, Czechoslovakia, France, Holland.

The Mirror Manufacturers Association will hold its next meeting in Pittsburgh, December 6 and 7.

The American Refractories Institute winter meeting will be held in conjunction with the American Institute of Chemical Engineers at the Chase Hotel on December 6.

Inquiries Received

For further information address THE GLASS INDUSTRY

388. We have an export inquiry for a bottle sealing machine which will have a capacity of 190 bottles an hour, the machine to operate 8 hours a day. The sealing material employed will be hard resin, wax or paraffin (Oct. 7).

389. Can you give me the names of manufacturers of opal jars? (Oct. 14).

390. I would like to obtain the names of the manufacturers of quartz glass and Corex glass (Oct. 20).

391. We have an inquiry from Europe for machines for making glass marbles and glass wool (Oct. 24).

What the World Wants

Specific Inquiries for American Goods, Received in the Department of Commerce, Washington, D. C.

Germany: 27525, glass-blowing machinery for making vacuum flasks.

Venezuela: 27496, plate and window glass.

South Africa: 27585, bottles for milk, catchup, etc., and jars.

Cuba: 27827, glassware.

Glass Stock Quotations

PITTSBURGH STOCK EXCHANGE, OCTOBER 22, 1927

Reported by Moore, Leonard & Lynch, Union Trust Bldg., Pittsburgh, Pa.

	Bid	Asked	Last
American Window Glass Machine, com.	20	25	21
American Window Glass Machine, pfd.	..	63	62½
American Window Glass, pfd.	..	..	100½
United States Glass	14¾	15½	15½
Pittsburgh Plate Glass, com.	210	..	210
Standard Plate Glass, com.	..	..	2½
Standard Plate Glass:			
Preferred cumulative	..	..	14
Prior preferred	25	..	33

TOLEDO, O., OCTOBER 21, 1927

	Bid	Asked	Last
Owens Bottle, pfd.	117	119	119½
Libbey-Owens Sheet Glass, com.	122½	123	122½
Libbey-Owens Sheet Glass, pfd.	115	..	115

WHEELING STOCK EXCHANGE, OCTOBER 21, 1927

	Bid	Asked	Last
Hazel-Atlas	70	70¾	70½
Imperial	..	..	72
Fostoria	200	..	208
Central	..	..	75

READERS WANTS AND OFFERS

Glassmaker — Superintendent open for position. Have had large experience in consulting work. Familiar with all factory conditions. Will guarantee good glass—Flint, Green and Amber. Used to all kinds of fuel. Will give references if required. Address, A-302, care of THE GLASS INDUSTRY, 50 Church St., New York.

Wanted—A glass product manufacturing plant in the Middle Atlantic States requires, immediately, a practical man to take complete charge of formula mixing and casting departments. One experienced with tank construction preferred. Reply stating age, nationality, qualifications and salary expected. All applications will be treated confidentially. Address: A-1, care of THE GLASS INDUSTRY, 50 Church St., New York.

Current Prices of Glass-Making Materials

October 21, 1927

Quotations furnished by various producers, manufacturers and dealers.

		Carlots	Less Carlots
Acid			
Citric (dom.)	lb.	.44½	.44½
Hydrochloric (HCl) 20° tanks, per 100 lb.		..	1.05-1.10
Hydrofluoric (HF) 60% (lead carboy)	lb.	..	.13½
52% and 48%	lb.	.10	.10-.11½
Nitric (HNO_3) 38° carboy ext. Per 100 lb.		5.50	5.75
Sulphuric (H_2SO_4) 66° tank cars	ton	15.00-16.00	..
Tartaric	lb.	.36-37	.37
Alcohol, denatured	gal.	..	.46
Aluminum hydrate ($Al(OH)_3$)	lb.	.04½-.05	.05-.05½
Aluminum oxide (Al_2O_3)	lb.	..	.07
Ammonium bifluoride (NH_4) FHF	lb.	..	.19-.21
Ammonia water (NH_4OH) 26° drums	lb.	.02½	.02¾
Antimony, metallic (Sb)	lb.	..	.11¼-.11¾
Antimony oxide (Sb_2O_3)	lb.	..	.14½-.16
Antimony sulphide (Sb_2S_3)	lb.	.15	.16
Arsenic trioxide (As_2O_3) (dense white), 99%	lb.	.04	.04¼-.04½
Barium carbonate ($BaCO_3$)			
Precipitated	ton	53.00	55.00
Natural, powdered, imported	ton	48.00	50.00
Barium hydrate ($Ba(OH)_2$)	lb.	..	..
Barium nitrate ($Ba(NO_3)_2$)	lb.	.08¼	.08½
Barium selenite ($BaSeO_3$)	lb.	..	..
Bone ash	lb.	.05	.05½
Borax ($Na_2B_4O_710H_2O$)	lb.	.03¾	.04-.04½
Boric acid (H_3BO_3)	lb.	..	.08¼-.08½
Refined	lb.	.08-.08¼	.08½-.08¾
Cadmium sulphide (CdS)—			
Red	lb.	..	1.20
Orange	lb.	..	1.10-1.25
Yellow	lb.	..	1.20-1.40
Chromium oxide (Cr_2O_3)	lb.	.27	.32
Cobalt oxide (Co_3O_4)			
In bbls.	lb.	..	2.10
In 10 lb. tins	lb.	..	2.20
Copper oxide			
Red (Cu_2O)	lb.	..	.30
Black (CuO)	lb.	..	.25-.30
Black prepared	lb.	..	.30
Cryolite ($Na_3Al\ F_6$) Natural Greenland Kryolith)	lb.	.09	.10-.10½
Artificial or Chemical	lb.	..	.09½
Epsom salts ($MgSO_4$) (imported) Per 100 lb.		..	1.15-1.30
Feldspar—			
100 mesh	ton	11.00-20.00	15.50-22.00
80 mesh	ton	..	14.50
40 mesh	ton	12.50	13.50
Fluorspar (CaF_2) domestic, ground, 95-98% (max SiO_2 2½%)			
Bulk, carloads, f.o.b. mines	ton	32.50	..
In bags or barrels	ton	36.50	41.50
Formaldehyde	lb.	.08½	.09
Graphite (C)	lb.	..	.04-.07
Iron oxide—			
Red (Fe_2O_3)	lb.	..	.04½-.07
Black (FeO)	lb.	..	..
Kaolin (f.o.b. mine)	ton	10.00	..
English, lump, f.o.b. New York	ton	13.00-23.00	..
Kryolith (see Cryolite)			
Lead chromate ($PbCrO_4$)	lb.	..	..
Lead oxide (Pb_3O_4) (red lead)	lb.	.09¾	.09¾-.10
Litharge (PbO)	lb.	.08¾	.08¾-.09
Lime—			
Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	12.50	..
Burnt (CaO) ground, in bulk	ton	9.00	..
Burnt, ground, in paper sacks	ton	11.00	..
Burnt, ground, in 280 lb. bbls.	Per bbl.	2.15	2.30
Limestone ($CaCO_3$)		2.00	..
Magnesia (MgO)—			
Calcined, heavy (in bbls.)	lb.	.05-.06	.07
light (in bbls.)	lb.	..	.23
extra light (in bbls.)	lb.	..	.37
Magnesium carbonate ($MgCO_3$)	lb.	.06	.07½-.08
Manganese 85% (MnO_2)	lb.	.04½	.05
Nickel oxide (Ni_2O_3), black— for nickel content	lb.	..	.35
Nickel monoxide (NiO), green— for nickel content	lb.	..	.35
Plaster of Paris, bags	ton	..	23.00
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals	lb.	.08¼	.08½
Ground	lb.	.11	.12
Potassium carbonate—			
Calcined (K_2CO_3) 96-98%	lb.	.06¾	.07½
Hydrated 80-85%	lb.	.06	.06½
Potassium chromate (K_2CrO_4)	lb.	..	.28
Potassium hydrate (KOH) (caustic potash)	lb.	.07½	.08
Potassium nitrate (KNO_3) (gran.)	lb.	..	.05⅞-.06
Potassium permanganate ($KMnO_4$)	lb.	.15	.15½
Powdered blue	lb.	..	.24-.26
Rochelle salts, bbls.	lb.	..	.23
Rouge	lb.	..	..
Rutile (TiO_2) powdered, 95%	lb.	.15-.20	.20-.25
Salt cake, glassmakers (Na_2SO_4)	ton	22.00	..
Selenium (Se)	lb.	..	2.10-2.15
Silver nitrate ($AgNO_3$)	oz.	..	.40½
Soda ash (Na_2CO_3) dense, 58%—			
Bulk, on contract	Flat per 100 lb.	1.22½-1.27½	..
In barrels	Per 100 lb.	1.55-1.57½	2.40
In bags	Per 100 lb.	1.37½	..
Spot orders	.05 per 100 lbs. higher		
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.06¼	.06⅝
Sodium hydrate (NaOH) (caustic soda)	Per 100 lb.	3.50	..
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls.	lb.	.03¾	.04
95 per cent	Per 100 lb.	2.45	2.80
Sodium selenite (Na_2SeO_3)	lb.	..	2.35
Sodium fluosilicate (Na_2SiF_6)	lb.	.04½-.05	.05-.05½
Sodium uranate (Na_2UO_4) Yellow or Orange	lb.	..	1.25
Sulphur (S)—			
Flowers, in bbls.	Per 100 lb.	3.45	3.80-4.00
Flowers, in bags	Per 100 lb.	3.10	3.45-3.65
Flour, heavy in bbls.	Per 100 lb.	2.85	3.20-3.40
Tin chloride ($SnCl_2$) (crystals)	lb.	.44	.44½
Tin oxide (SnO_2) in bbls.	lb.	.63	.64
Uranium oxide (UO_3) (black, 96% U_3O_8) 100 lb. lots	lb.	..	1.25-2.25
Zinc oxide (ZnO)	lb.	.06½	.07
Zircon			
Granular (Milled .005-.02c higher)		.07	.07½-.08
Crude, Gran. (Milled .005-.02c higher)		.03½	.04-.05

Monthly Summary of United States Foreign Commerce in Glass

EXPORTS

Corrected to September 23, 1927

	August 1926 Quantity	August 1926 Value	August 1927 Quantity	August 1927 Value	Eight Months Ending August 1926 Quantity	Eight Months Ending August 1926 Value	Eight Months Ending August 1927 Quantity	Eight Months Ending August 1927 Value
Glass and glass products (total)	.....	$711,093	.....	$693,138	.....	$5,889,740	.....	$5,872,048
Plate and window glass—								
Window glass, common, box 50 sq. ft.	1,941	10,654	2,111	9,909	21,417	120,255	15,856	84,615
Plate glass, unsilvered, sq. ft.	33,334	20,258	156,122	44,340	728,528	192,820	705,382	225,265
Other window and plate glass lbs.	257,178	32,819	238,466	38,824	1,609,637	167,681	2,935,717	301,323
Glass containers (bottles, vials and jars)	.....	268,406	.....	257,047	.....	1,966,948	.....	2,046,289
Table glassware, plain	.....	115,225	.....	94,401	.....	1,072,223	.....	946,641
Table and other glassware, cut or engraved	.....	10,527	.....	16,021	.....	117,380	.....	93,751
Lamp chimneys and lantern globes lbs.	182,712	31,354	109,016	23,037	1,514,722	279,635	1,328,302	271,896
Globes and shades for lighting fixtures lbs.	116,047	43,949	124,453	43,055	1,125,740	368,660	1,142,083	413,376
Chemical glassware lbs.	15,045	15,003	19,285	15,985	142,973	132,720	136,554	123,291
Electrical glassware, except for lighting lbs.	450,701	30,034	141,868	17,718	3,993,965	337,497	1,624,050	161,310
Other glassware	.....	132,864	.....	132,801	.....	1,133,921	.....	1,204,291

IMPORTS

Corrected to September 23, 1927

Glass and glass products	.....	1,768,375	.....	1,526,948	.....	13,702,143	.....	11,102,985
Cylinder, crown and sheet—								
Unpolished dut. lb.	6,815,768	222,736	.....	.....	54,089,062	2,198,186	.....	.....
Weighing less than 80 pounds per case dut. lb.	.....	.....	4,032,429	106,025	.....	.....	33,073,615	853,691
Weighing 80 pounds or over per case dut. lb.	.....	.....	2,831,914	102,961	.....	.....	27,851,932	1,186,147
Bent, ground, beveled, colored, painted, etc., and polished dut.	.....	28,248	.....	35,856	.....	376,404	.....	256,476
Plate glass dut. sq. ft.	2,214,876	732,156	.....	.....	18,370,891	6,025,863	.....	.....
Polished, unsilvered dut. sq. ft.	.....	.....	1,446,257	366,164	.....	.....	11,316,126	3,241,245
Other dut. sq. ft.	.....	.....	123,644	26,256	.....	.....	791,523	187,809
Bottles, vials, jars, demijohns and carboys, molded or pressed dut.	.....	21,923	.....	16,601	.....	189,767	.....	128,037
Table and kitchen utensils dut.	.....	8,829	.....	21,826	.....	83,870	.....	88,401
Glassware, cut or decorated dut.	.....	300,992	.....	330,245	.....	1,728,569	.....	2,278,642
Blown glassware, n. e. s.—								
Bottles, ornaments, gauge glasses and other n. e. s. dut.	.....	209,614	.....	257,581	.....	1 012,899	.....	916,764
Bulbs for electric lamps dut. No.	1,369,092	14,585	1,170,403	10,800	12,684,776	141 621	9,566,704	90,268
Chimneys, globes, shades, prisms and other illuminating glassware dut.	.....	78,859	.....	92,870	.....	680,619	.....	590,727
Articles and utensils for chemical, scientific, and experimental purposes dut.	.....	38,383	.....	44,632	.....	374,374	.....	352,085
Other glassware dut.	.....	112,050	.....	115,131	.....	919,881	.....	932,693